Deviceworx Technologies Inc.

xTAG Explorer App

for

xTAG BLE Environmental Sensor

Users Guide

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Revisions

| Rev	Author	Notes	Date
1.0	Mark Janke	Original Draft.	Dec 17, 2021
2.0	Mark Janke	Typo fixes.	Dec 21, 2021

Overview

This document is intended to provide users of the Deviceworx xTAG BLE Environmental Sensor ("xTAG" within the remainder of this doc unless stated otherwise) with details on how to use the xTAG along with its supporting xTAG Explorer Android App. The xTAG incorporates a Bluetooth Low Energy (BLE) transceiver with an Environmental sensor chip on its top membrane. The xTAG Explorer App communicates with xTAG devices for monitoring and configuration purposes over BLE 5.0 to a maximum distance of 300' (100 m).

xTAG Explorer App Support for All Deviceworx xTAGs

The xTAG Explorer App also supports the management of other xTAG types including xTAG BLE Vibration Sensors, listing all xTAG types on its main screen. Selecting a listed xTAG opens a Detail screen that is specific to the type of xTAG selected. This document covers only the screens visible when interacting with xTAG BLE Environmental Sensor devices. For information on xTAG Explorer screens supporting other xTAG types (e.g. the xTAG BLE Vibration Sensor), please consult Deviceworx for appropriate user documentation.

xTAG BLE Environmental Sensor

The figure below shows an xTAG BLE Environmental Sensor
.
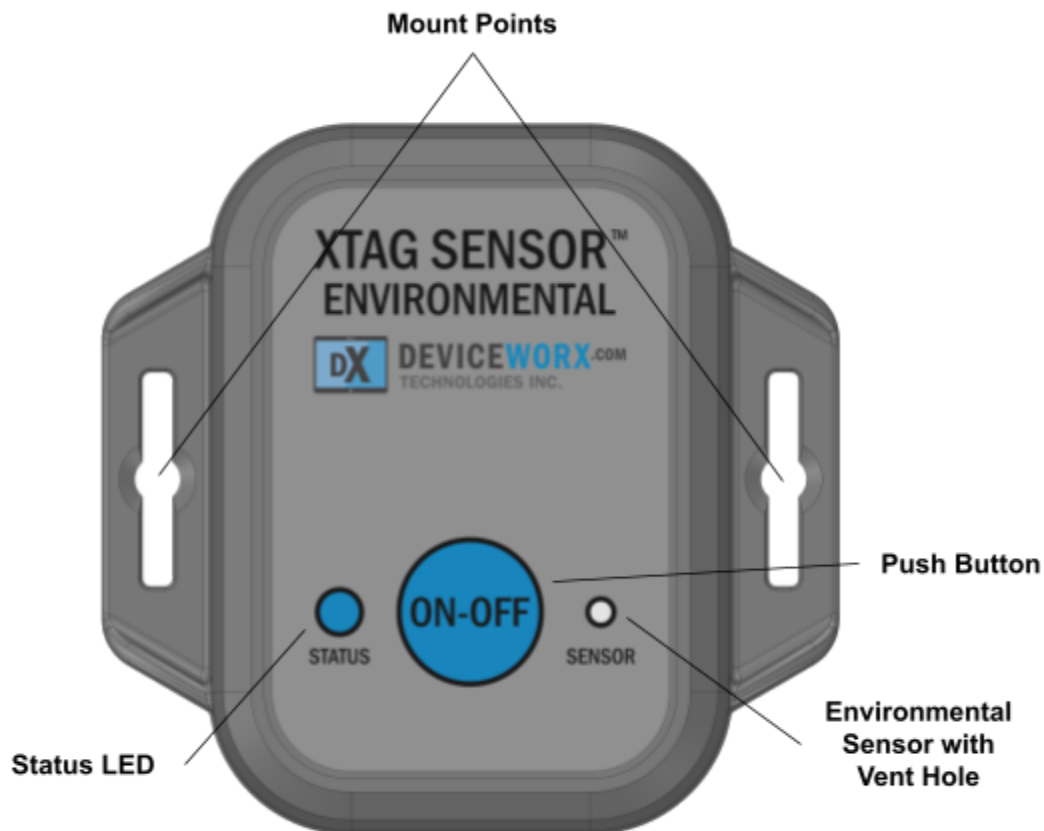
Mount Points

The enclosure includes flanges to support mounting the xTAG on a wood or metal base. Because the internal xTAG antenna is 30 mm+ away from the xTAG's base, BLE comms are not adversely affected by RF issues related to mounting XTAGs on metal base structures.

Status LED

The Status LED (blue or green) will flash on occasion to indicate the status of the xTAG. At present, only the following status indications are provided:

- Flash ON 5 times in approx 3 seconds whenever the xTAG starts or restarts (i.e. new battery inserted or new firmware loaded during manufacturing).
- Flash ON 2 times quickly whenever the xTAG **starts** transmitting beacons to support interaction with the xTAG Explorer App.
- A single longer LED flash occurs when the button is pressed and held for a couple seconds to stop beacon transmission. Beacon transmission on/off control is typically used to support transport of xTAGs: xTAGs can be transported without removal of their battery if they are not transmitting beacons.

Push Button

This button turns BLE beacon transmissions on and off. See the Status LED section above for detail on LED indications for beacon transmission status.

Environmental Sensor with Vent Hole

An environmental sensing chip has been installed within the membrane on the top of the xTAG. There is a very small vent hole in the membrane (1 mm) providing air with access to this chip. It is critical that this hole does not become plugged up as this will prevent ambient air from reaching the sensor chip and it will not provide accurate readings. If the xTAG is used in an environment where there is lots of dust or any other debris that could clog the vent hole, ensure that the xTAG is periodically cleaned to ensure that there is a path for ambient air to reach the sensor chip.

xTAG Explorer App

The xTAG Explorer App (or "App" for brevity) is available for install from the Google Play Store. Note that Apple devices are not supported. Also note that the App works best on the Lenovo Tab P11 Plus running Android 11. Other Android tablets may work, but only the Tab P11 Plus has been validated by Deviceworx. These tablets are inexpensive (approx $230 USD) and can be easily purchased worldwide. If another tablet is used, validating that it supports 1080p or better resolution and Android 11 will ensure that App screen layouts are optimized. Importantly - Deviceworx validation testing indicates that Lenovo Tab P11 Plus tablets include the most robust BLE support and are recommended.

The figure below shows the Home screen within the App. This screen lists nearby xTAGs (that are currently beaconing) and is refreshed periodically or can be refreshed immediately at any time by pressing the "RESCAN" below the list.
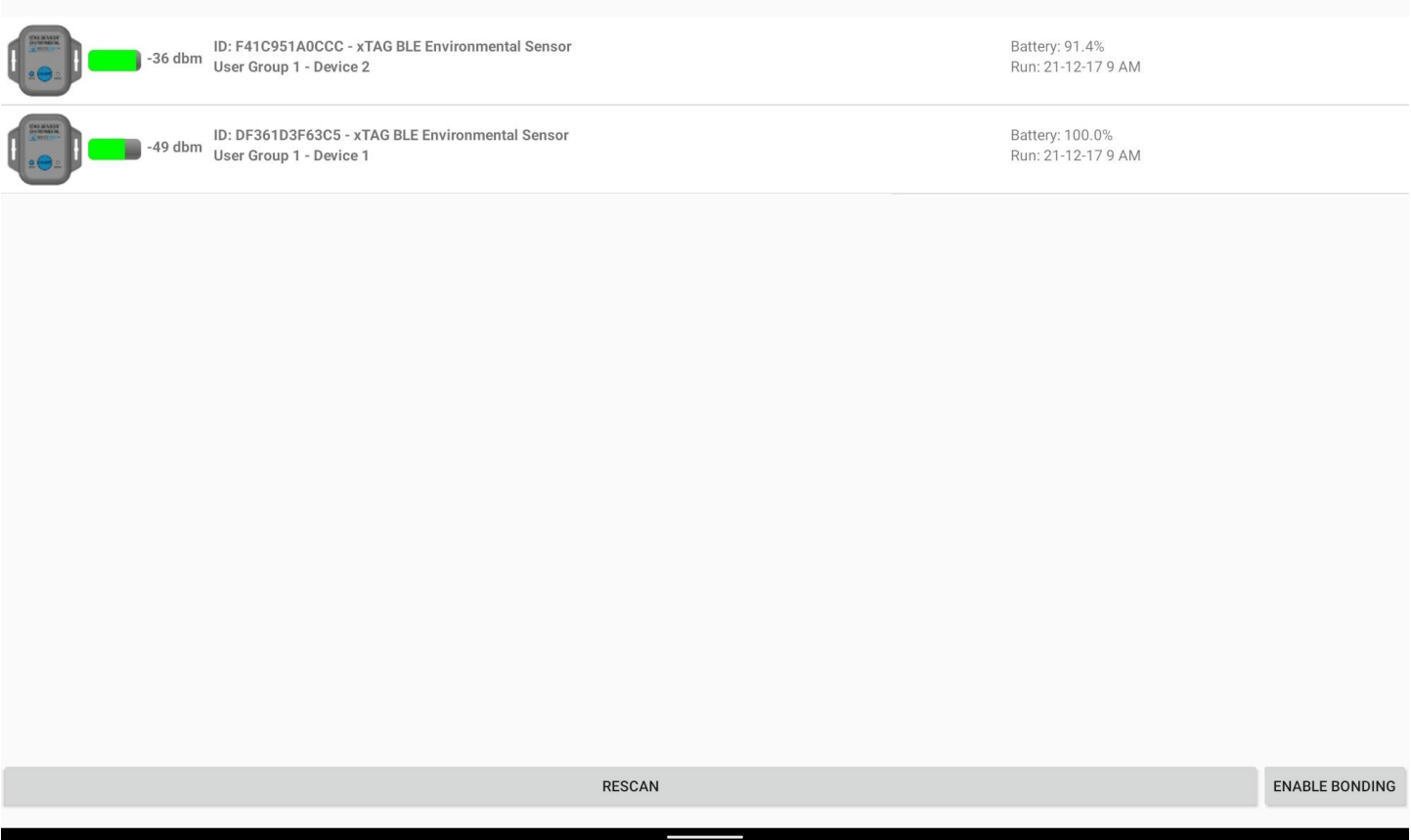
Each listed device will contain (on the left) the device information shown in the figure below.

ID: F41C951A0CCC - xTAG BLE Environmental Sensor
-36 dbm
User Group 1 - Device 2
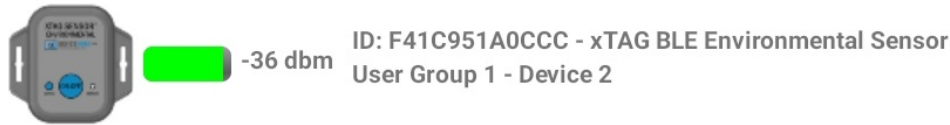
- ID: Each xTAG has a universally unique ID. This ID is the fixed Bluetooth Address of the xTAG. Note that the type of xTAG is also listed with the ID ("xTAG BLE Environmental Sensor" in the figure above).
- User Group ID: This unique number ("1" in the figure above) can be set within the App (covered in following sections) to group devices. This allows devices to be identified more effectively by users before BLE connections are made.
- User Device ID: This unique number ("2" in the figure above) can also be set within the App to identify the xTAG device within a group.
- Signal Strength: A color-coded bar indicates the strength of the BLE signal. No color indicates a very low signal strength, red indicates a low signal strength, yellow denotes an OK signal strength, and green denotes a very strong signal strength. To the right of the bar, the actual signal strength in dbm is shown. To improve signal strength, get closer to the xTAG or increase its transmission (Tx) power level (discussed in a section that follows.

Each listed device will contain (on the right) the device information shown in the figure below.

Battery: 91.4%
Run: 21-12-17 9 AM

- The percentage of battery remaining **as it relates to voltage**. This percentage shows the level of the battery between 3.0+ VDC (100 percent) and 2.2 VDC (0 percent). Because battery voltages are not linear, this percentage will not be linear. In general, the battery will stay at a level above 75 percent (2.8 Vdc) for a very long time and then it can drop quite quickly to 0 percent. Note that low ambient temperatures can lower a battery's voltage.
- Run: The date and time that the firmware (software) started on the xTAG. In general, this date should match the date of manufacture, or the date when a battery was last inserted into the xTAG.

xTAG Connection and Use

BLE Pairing and Bonding

From version 2 forward, the xTAG Explorer supports secured access to xTAGs. This is accomplished through the BLE pairing and bonding process. Bonding simply stores pairing data so that pairing only has to occur once. Specifically, xTAGs utilize Passkey pairing (user enters 6 digits to pair) for strong credentialed access with encryption. Passkey pairing is supported by the more secure Low Energy Secure Connections (LESC) standard. Each xTAG customer is assigned their own unique 6-digit pin. If Passkey Pairing is enabled on their xTAGs they must enter this passkey once when connecting to their xTAGs for the first time. Android will open a dialog in which the 6-digit pin can be entered and a pop-up message will be displayed at the bottom of the screen when pairing is completed and the tablet and xTAG are bonded. No further pairing action will be required and subsequent connections to a bonded xTAG will just proceed when requested in the app.

An "ENABLE BONDING" button is shown at the bottom right corner of the xTAG Explorer home screen. If pairing and bonding is required for xTAGs, press this button. This enables the app to take extra steps that make the pairing and bonding process simpler. You can still pair and bond without enabling bonding in the app, but the process will be unclean and may result in some misleading error messages and may require multiple pair/bond attempts.

If an xTAG requires pairing

If another Android device is connected to the same xTAG, that new Android device will also have to be paired and bonded with the xTAG. To disable secure access to any xTAG, simply "unpair" the xTAG from the Android device within the Android Bluetooth settings.
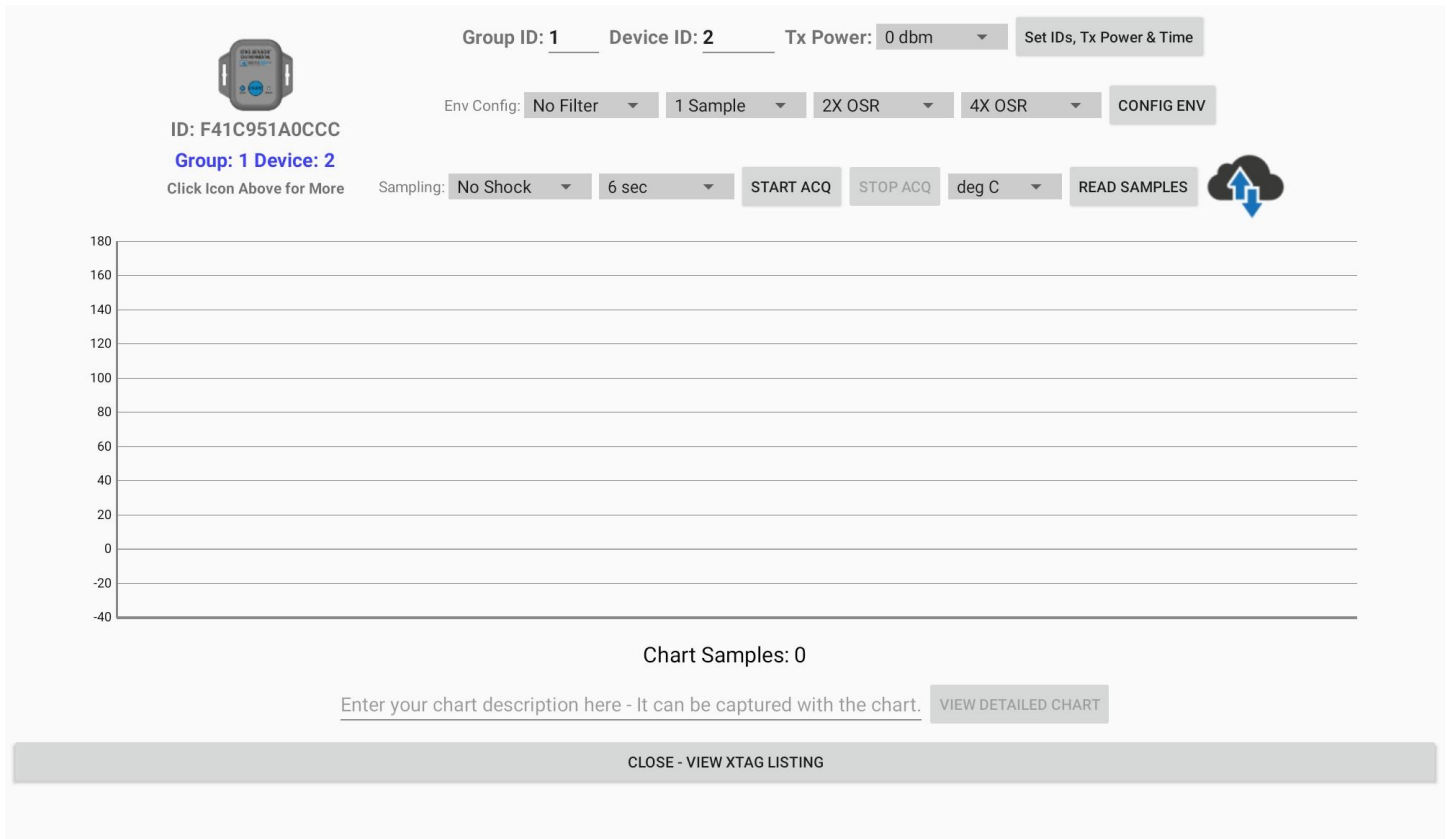
xTAG Connection

Connect to any xTAG by selecting it within the Home screen. BLE connections can take 5-15 seconds and can fail intermittently. Once connected, however, BLE connections are retained very effectively. If a connection to an xTAG fails, the home screen will be re-opened and xTAGs nearby will be re-scanned. Re-select the xTAG to attempt another connection. If no pairing to the xTAG is required (because a bond already exists from a previous pairing or pairing and bonding is not required), the xTAG Detail screen will be opened with controls populated.

If this is the first connection between the Android device and the xTAG and pairing is required, a Passkey Entry Dialog will be opened as shown below..
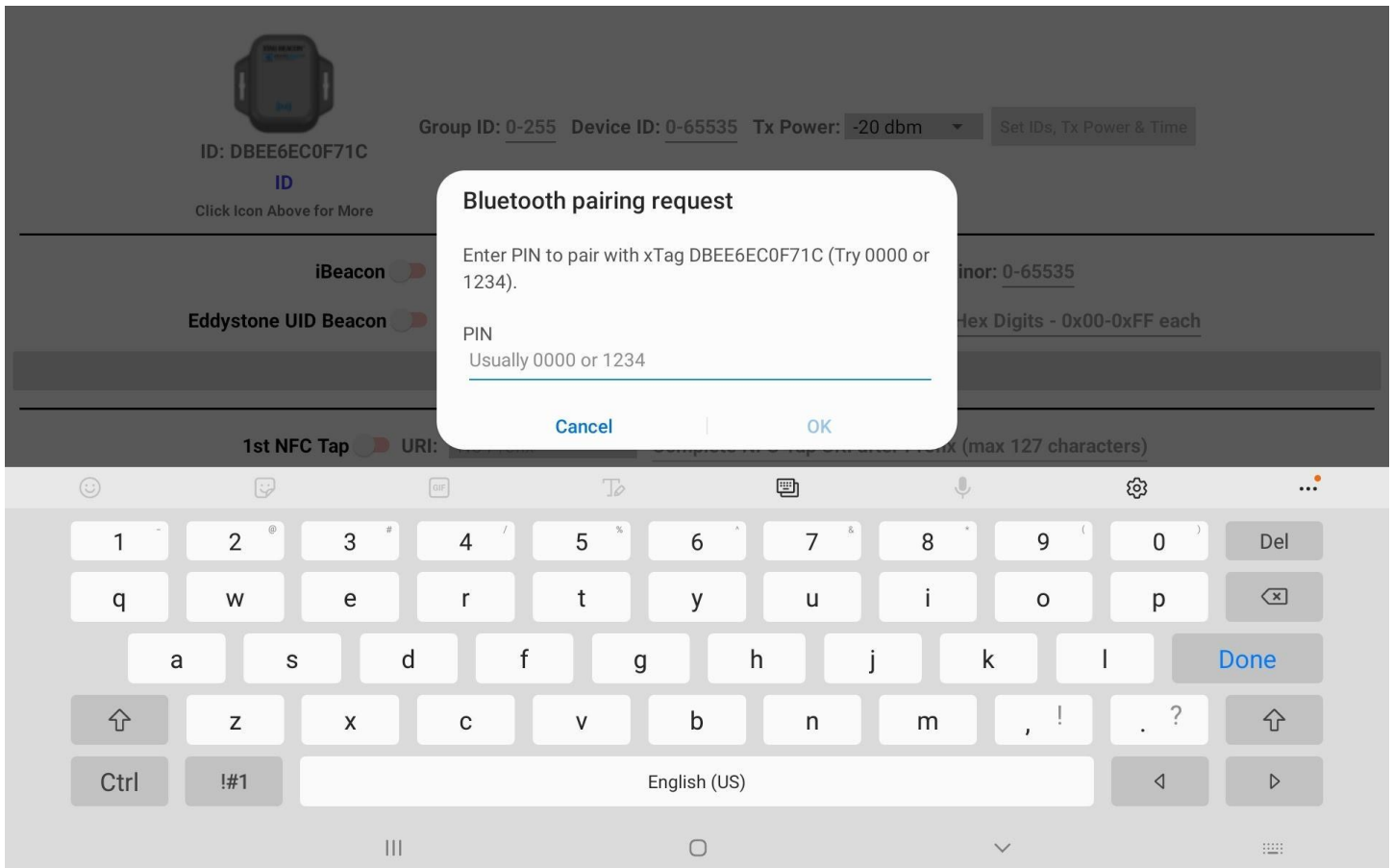
If a Passkey Entry Dialog is opened, the user must enter their 6-digit pin and select OK. Pairing will be completed and the xTAG will be bonded so that no future pairing is required. The Detail screen will close. Re-select the xTAG within the list and it will be opened without the need to enter a passkey to pair as the xTAG will be bonded to the Android device.

When the Detail screen is opened by selecting a device, data is fetched from the xTAG and information such as the Group and Device IDs are displayed as shown in the figure below.

To see more xTAG device details, click on the icon to open the "xTAG Details" dialog box shown below.

The details include hardware and firmware revisions, how long firmware has been running and the currently stored Unix time within the xTAG. The NFC ID is shown as "Unsupported" for any xTAG type other than the xTAG BEACON.

Additional functions supported within the Details screen are discussed below.

Set xTAG IDs, Tx Power and Time

To identify and group xTAGs for easier identification within the xTAG list in the Home screen, enter a group ID (0-255) and device ID (0-65535). Next, select an appropriate transmit (tx) power level. xTAGs can save power by using a negative power level or power level of 0 dbm, or they can tx further when required and utilize slightly more power when a higher power level is selected. As a guide, select 0 dbm for 10-15 m connection range, 4 dbm for 100 m and 8 dbm for 300 m. Next, press the "Set IDs, Tx Power & Time" button to store IDs, tx power and the Android tablet date and time (used for timestamping sensor data) within the xTAG. A temporary confirmation pop-up message will be displayed near the screen bottom when the process is complete.

Configure the xTAG Environmental Sensor

Before acquisition, the xTAG's environmental sensor chip must be configured for use.

Select an IIR Filter, enable independent temperature, pressure and humidity sampling and select oversample rates (OSRs) for temperature, pressure and humidity sampling.

IIR Filtering

The environmental sensor can apply an IIR filter to temperature and pressure measurements (but not humidity). IIR filtering can remove short term fluctuations in these parameters. For example the effect of wind on pressure. An IIR filter coefficient can be selected (1-127) or IIR filtering can be disabled ("No Filter" selected). The same IIR filter coefficient will be used for both temperature and pressure sampling. If unsure about an IIR filter requirement, leave it disabled (select "No Filter"). Data processing on data samples can (in effect) handle transients just as well as the sensor's IIR filter. Google IIR filtering for more detail on how an IIR filter works on a data stream.

Enabling Temperature, Pressure and Humidity and Selecting OSRs

Individual controls are provided to enable temperature, pressure and humidity and select their OSR rates.

Temperature should always be enabled and commonly a single sample is all that is required. Even if temperature data will be unused, it is important to enable temperature sampling as sampled temperature is used by the environmental sensor chip to calculate pressure and humidity sample values. Select "1 Sample" to enable simple temperature sampling without oversampling. Or, select an OSR rate from 2X to 16X. Deviceworx strongly recommends the "1 Sample" selection.

Pressure sampling commonly requires some (but very little) oversampling. If pressure data is of interest, Deviceworx recommends selecting an OSR of 2X. If not, disable pressure sampling by selecting "Disabled". Note that pressure sampling should be enabled if humidity sampling is required (e.g. "2X OSR").

Humidity sampling also requires some oversampling. Deviceworx empirical testing has found that an OSR rate of 4X seems to provide good accuracy and that higher OSR values do not materially affect sample accuracy. Disable Humidity sampling by selecting "Disabled" or select a Deviceworx-recommended OSR of 4X.

After selecting an IIR Filter, selecting enable settings and selecting OSR settings, press the "CONFIG ENV" to update the environmental sensor chip. Note that the current values within the chip are read into the tablet whenever the Detail screen is opened.

Start and Stop Environmental Data Sampling

Before acquisition, the xTAG's environmental sensor chip must be configured as described within Configure the xTAG Environmental Sensor above. Additionally, a shock threshold and sample period must be selected.

Shock Threshold

The xTAG BLE Environmental Sensor includes an Inertial Measurement Unit or IMU. This IMU can be used to measure a shock event. A G-force threshold (in Gs) can be specified and if specified, the sensor will create a timestamped sample with temperature equaling -999 degC if the sensor is shocked with a force greater than the specified threshold. This feature is intended to support logging of shock events that can dramatically affect high-value products during shipping including medicine, vaccines and produce. Note that shock sensing can have a dramatic effect on xTAG battery life (up to 25% reduction). If unsure if shock events are required, leave the shock threshold selection at its default value of "No Shock".

Sampling Period

A sampling period stipulates how often the xTAG will take temperature, pressure and humidity samples (when independently enabled). Higher sample rates will reduce battery lifespan. Typically, sensing more frequently than every 30 min is discouraged - unless sampled environmental variables are expected to be very volatile. Note that the sensor can store up to 5000 samples before older samples are replaced by newer samples. Consider sample rates and expected sensor cloud synchronization intervals (discussed below) when planning an xTAG deployment. For example, selecting a sample rate of 30 min stipulates that 48 samples will be collected per day and therefore it will take 5000/48 or 104.167 days (104 days plus 4 hours) before the sensor buffer is full. xTAG synchronization with the cloud (using the app) will have to occur more frequently than every 104 days to avoid data loss. Selecting a sample period of 1 hr extends this to 208 days and 8 hours.

Sampling Start

Once configuration is complete and both shock threshold and sampling period are selected, press the "START ACQ" button to start sample acquisition (or sampling). Once sampling has started and a sample period has elapsed, samples can be read (described below). Sampling does not have to stop in order to read samples.

Sampling Stop

Once sampling has started, the "STOP ACQ" button is enabled. Select this button to stop acquisition of samples (or sampling). Data can be read when sampling is stopped.

Read Data Samples to the Tablet

Any time after 1 or more samples have been acquired, samples can be read. Select the temperature units in which to view data (degrees Celcius or Farenheit) and then press the "READ SAMPLES" button to read all previously acquired samples from the xTAG. Sample reads can occur during sampling or after sampling has stopped.

Critically - sample data is deleted from the xTAG whenever it is read into the app. Read data will remain in the app buffer as long as the app is running or until it is transferred to the cloud (see Sync Tablet Data with the Cloud). Data can be read from the xTAG multiple times and it will simply increase the available chart samples and samples that can be sync'd to the cloud.

Data samples that have been read into the tablet app are displayed within a chart and the amount of data samples stored within the app are displayed below the chart (e.g. "Chart Samples: 22"). See the example screen capture below.
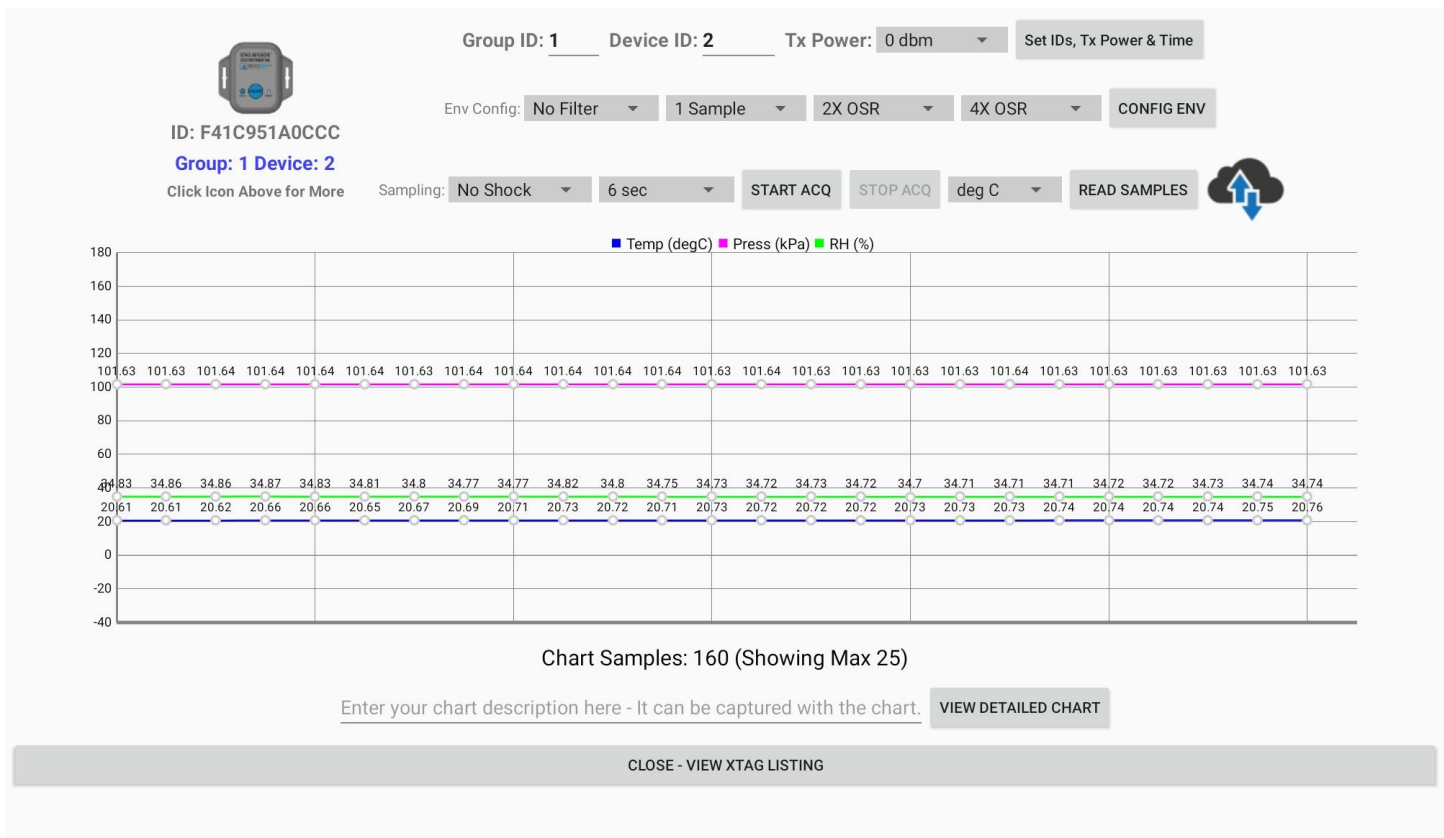
Note that only the last 25 samples are shown within the chart whenever more than 25 samples have been read.

Further note that if temperature, pressure or humidity is disabled, they will contain a value of -99 for each sample and will not show up within the chart. -99 denotes them as disabled in data.

Sync Tablet Data with the Cloud

Whenever an internet connection is available, the xTAG Explorer app supports copying sampled data to the Google Cloud for subsequent reporting. This Cloud-Sync of sampled data records is initiated when the Cloud icon on the right of the "Set IDs, Tx Power & Time" button is selected (within the Device Detail screen). All chart samples available within the app (that have been read from the xTAG) are sync'd with the Deviceworx datastore in the Google cloud for selection within reports. The "Chart Samples:" label near the bottom of the screen will change to "Chart Samples Sync'd:" and will count up until it has completed the sync. Then, it will show the total number of samples sync'd (e.g. "Cloud Samples Sync'd: 1731"). After sync, the chart will be empty to reflect the fact that the app sample store will now be empty.

Remember that each xTAG can store up to 5000 sample records and that sync of this number of records over a fast internet connection requires about 10 seconds.

After sync, data is removed from the xTAG.

Detail Chart

To get more information on acquired data samples, users can view a Detail Chart. First, an optional chart description can be provided below the current chart. This description is useful if the Detailed Chart is to be exported for later reference (described within Detail Chart Screen Capture Exports and Detail Chart CSV File Exports sections that follow). Next, press the VIEW CHART button to open the detail chart within a new screen.
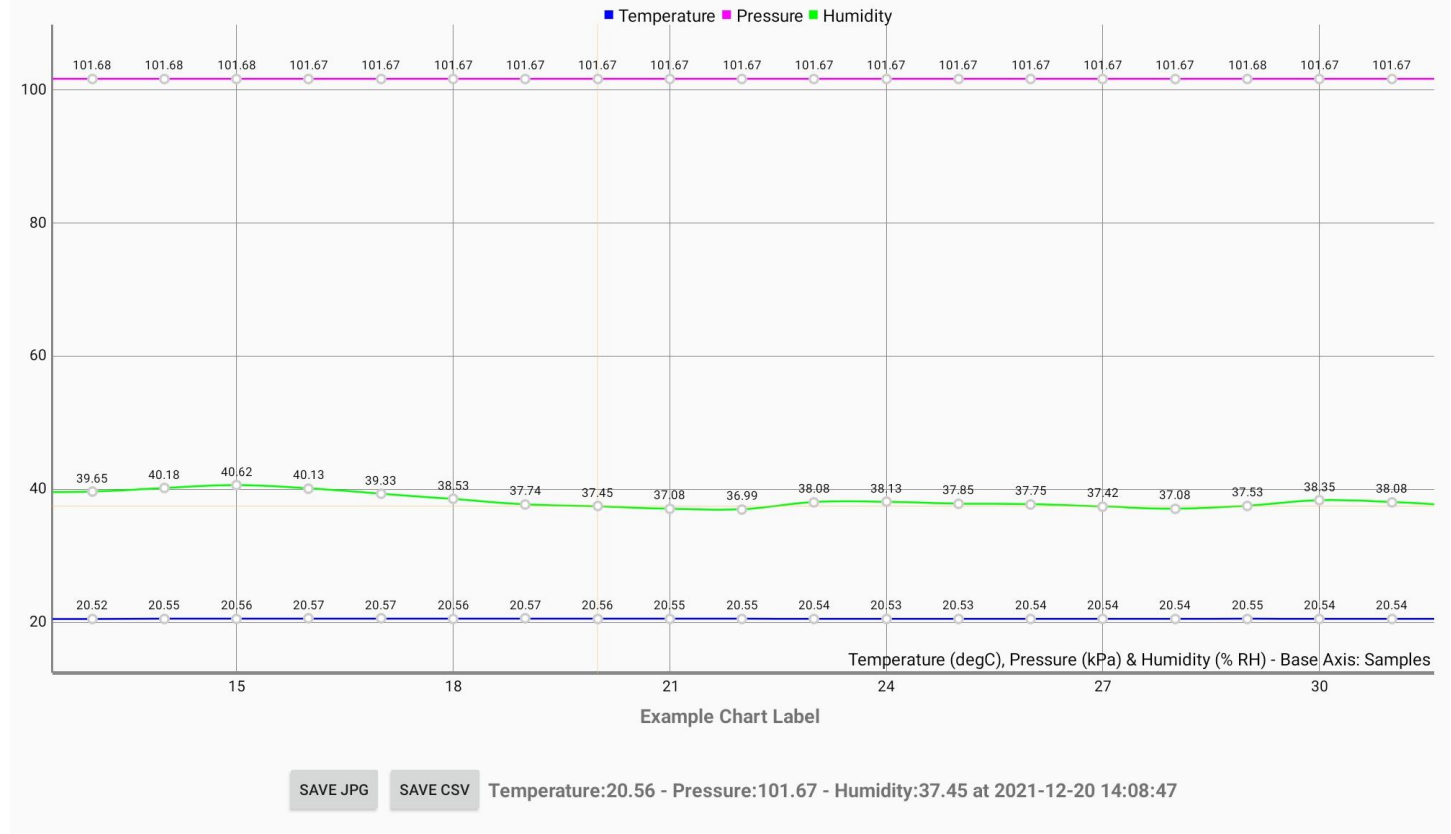
Detail Chart Zoom and Scroll Control

Within the Detail Chart, the touchscreen can be used to zoom in and out within the chart view (tighten pinched fingers **horizontally** with sustained touch to zoom out or widen fingers **horizontally** to zoom in). Note that the x-axis scale values will change based on the amount of zoom applied and the y-axis will change automatically as the chart will automatically scale vertically to properly show data within the chart view.

To scroll left or right, simply drag a single finger **horizontally** on the touchscreen. X-axis values will scroll to match movement and y-axis values will change automatically as the chart scales data vertically to best show data within the Detail Chart view.

Note that data values are only shown within the Detail Chart when space allows. If too many samples are shown, only dots or circles are shown for samples. Zoom in and eventually, data values will be shown next to circles (as in the screen capture above).

Detail Chart Data Selection

Carefully touch any line within a chart and the closest line data point to the touch will be selected as indicated by a thin orange vertical line. Data values that correspond to the selected point will be shown below the chart, along with their local timestamp (based on the time zone of the tablet). See the screen capture above for an example vertical line with corresponding values. Note that each data point on chart lines is denoted by a small grey circle and when data points are compressed, lines can look grey in color.

Detail Chart Screen Capture Exports

For simple backup of data shown on the Detail Chart screen, users can store an image of it using the SAVE JPG button.

Chart jpeg files are stored within the tablet \Download folder.

Chart jpeg file names conform to the following format:

xTagChart_EnvTPH]_[Device ID]_[YYYYMMDDHHmmSS].jpeg

- ● [Device ID] denotes the static device ID.
- ● [YYYYMMDDHHmmSS] denotes file creation year, month, day, hour, min and second (local time to the tablet).

An example filename is: xTagChart_EnvTPH_F41C951A0CCC_20211220023707.jpeg

Detail Chart CSV File Exports

To create custom reports within Microsoft Excel, users can store Detail Chart data with Comma Separated Values (CSV) files using the SAVE CSV button.

Chart csv files are stored within the tablet \Download folder.

Chart csv file names conform to the following format:

xTagChart_EnvTPH_[Device ID]_[YYYYMMDDHHmmSS].csv

- [Device ID] denotes the universal static device ID.
- [YYYYMMDDHHmmSS] denotes file creation year, month, day, hour, min and second (local time to the tablet).

An example filename is: xTagChart_EnvTPH_F41C951A0CCC_20211220023921.csv

Labeled sample metadata is stored as the first line within the CSV file. Data headers are stored in the second line and subsequent lines store data samples. The rows below provide an example. Note that there are always 2 implied decimals on temperature data (i.e. it is stored as 100x), 3 implied decimals on pressure data (ie it is stored as 100x), and 3 implied decimals on humidity data (i.e. it is stored as 100x).

Description:	Sample Chart Descriptions	Temp: degC	IIR: Off	Temp OSR: 1X	Pressure OSR: 2X	Humidity OSR: 4X
Unix time - GMT	Temp(100x)	Press(1000x)	Humid(1000x)			
1640040899	2115	101702	37213			
1640041046	2120	101705	38850			
1640041052	2126	101709	39305			
1640041058	2130	101709	39147			