OSCOR® MAX

PORTABLE SPECTRUM ANALYZER

Quick-Start Guide

REI®

Research Electronics International, LLC

OSCOR® Max

Quick-Start Guide

Revision 1.1

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Introduction

The OSCOR Max spectrum analyzer is the latest addition to REI's OSCOR product line. This Quick-Start Guide is intended to familiarize a new user with the basic features, general operation, and hardware setup.

Precautions

- Take care to protect the **2.4 Connector** with the provided dust cap when the connector is not in use. The connector is vulnerable to static discharge. (See p.3)
- Use the kickstand whenever the OSCOR Max is placed on a surface to facilitate air circulation. Soft surfaces are not recommended.
- The USB Type-C interfaces do *not* support Thunderbolt devices or protocols.

Equipment Description

OSCOR Max Inputs/Outputs

Device Back

1) 2.4 mm Connector — supports 9 kHz – 43 GHz (see p.3 caution)
2) 2.92 mm Connector — supports 9 kHz – 18 GHz antennas, including the provided DA -16 Directional Antenna
3) USB-C MPP — (USB 2 only, does not support OSCOR Max Power Supply)
4) IF out — SMA Connector
5) WiFi EXT — SMB Connector
6) Micro SD card slot
7) Ethernet Port
8) USB Port
9) USB-C Port 1
10) USB-C Port 2

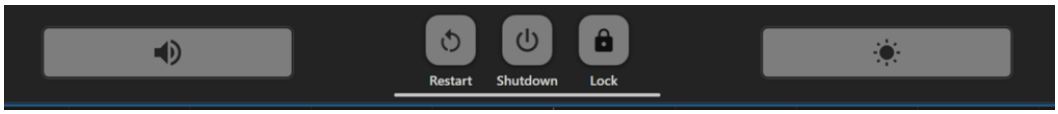
    For both USB-C ports 1 and 2:
    - USB-C 3.1 Gen2 PD AM
    - PD – Power Delivery
    - AM – Alt Mode
11) Headphone Port
12) Kensington Lock Slot
13) Microphone Port (for future applications)

Main Display

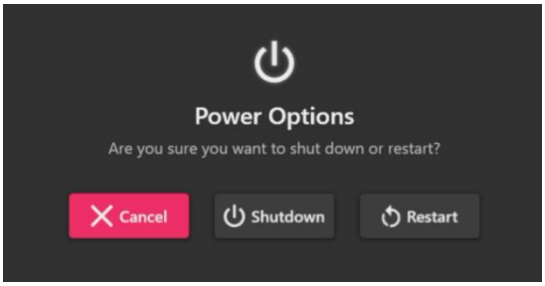
Powering On/Off

To view the touchscreen display, lift the antenna panel. On the main display, the power button is located above the top-left corner of the touchscreen. To power on, press the power button. To power down the unit:

- Swipe down from the top of the display
- Select **Shutdown** from the options in the power panel (note this panel also contains the volume control and display brightness controls)



- Select **Shutdown** from the pop-up ***Power Options***



Or

- Tap the power button to bring up the pop-up ***Power Options***
- Select **Shutdown**

Touchscreen Display and Mode Selection

Mode Selector — to bring up all *Modes* (which are hidden on first powering up), press the current mode icon in the upper left corner (this also hides the Mode-Specific Options)

Mode-Specific Options — to access Mode-Specific Options, press the current mode icon (this will hide the Mode Selector). Selecting these options will bring up various panels on the right and/or bottom of the screen, depending on each mode and selected tool.

Status Bar — This bar is displayed in all modes and contains the clock, battery status, current mode, etc.

Spectral Settings — This area is present in Sweep, Analyze, SmartBars™, and Spectrogram. It contains frequency information and keypad input controls.

Quick-Start Exercises

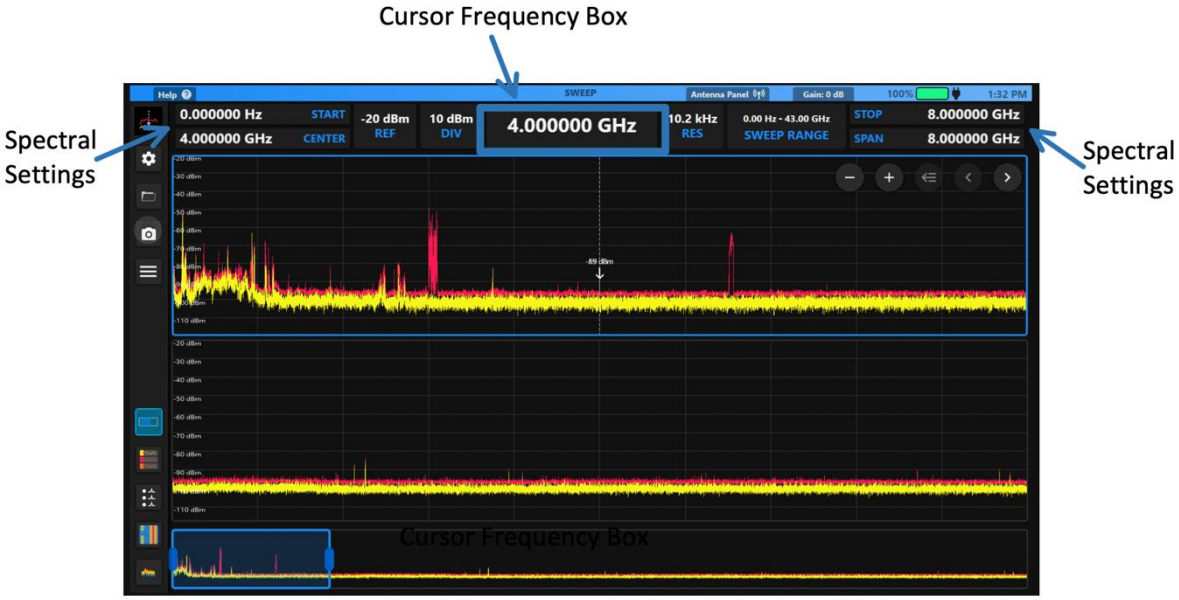
This section provides short exercises to familiarize the user with basic OSCOR Max functions and capabilities. These exercises are provided with minimal explanation and assume that the unit is turned on before starting. Detailed explanations of OSCOR Max functions and procedures will be provided in the upcoming User Manual. Six (6) exercises are provided:

Exercise 1: Analyze Mode *(Find a Radio Station)*

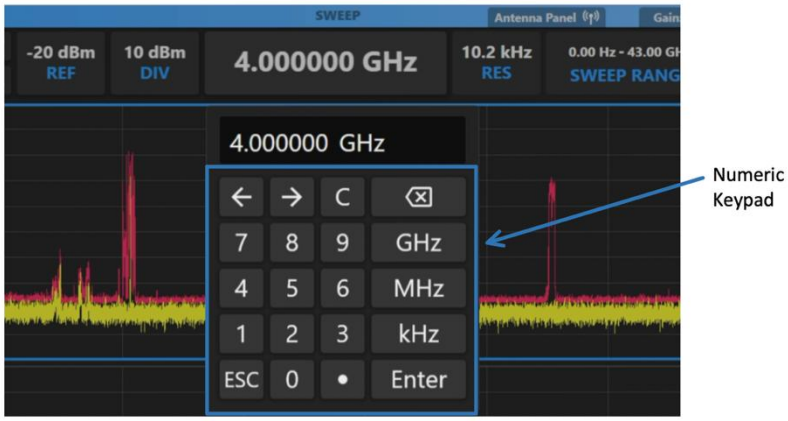
This exercise directs the user to tune into a local radio station using both Sweep and Analyze modes to demodulate the signal. During the exercise, the user can also practice using the touchscreen controls.

The default mode when powering on the OSCOR Max is Sweep Mode. This mode sweeps the full spectrum between 10 kHz and 43 GHz. (Sweep Mode Options are Detail Zoom, Traces, Signal List, Raster Waterfall, and Persistence). To find and listen to a radio station, perform the following steps:

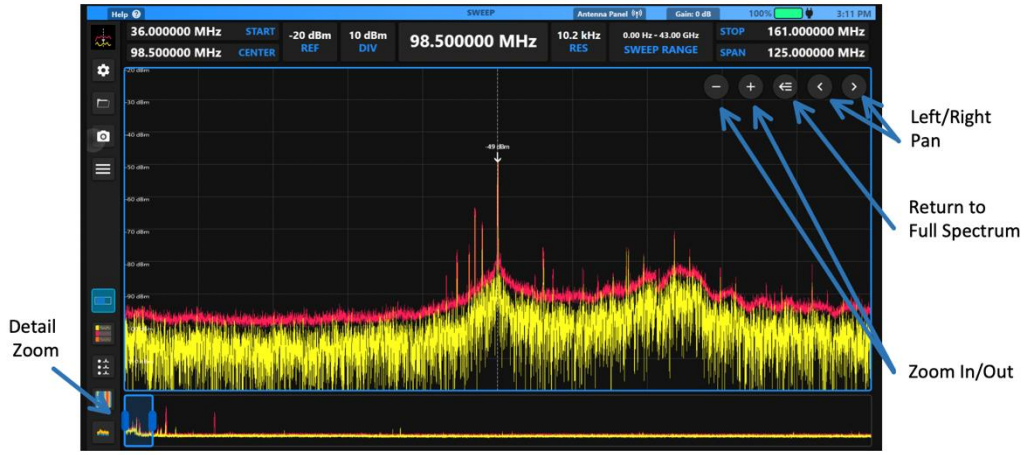
1) In ***Sweep Mode,***  tap inside the **Cursor Frequency Box** (located in the ***Spectral Settings***) to bring up the numeric keypad



2) Type the frequency of the desired radio station in the numeric keypad and either select the unit (or press **Enter** if the appropriate unit is already selected)

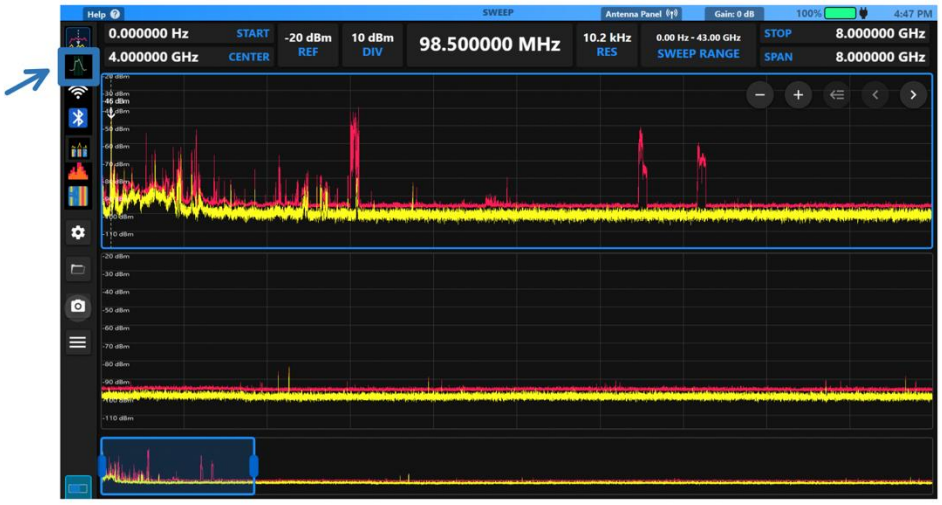


It is not necessary for this exercise, but if desired, zoom in on the signal by pressing the **Zoom In** button (Note: Zoom Out, Return to Spectrum, Detail Zoom, and Pinch-to-Zoom are available to control the touchscreen display). The full spectrum will always be displayed at the bottom of the screen.

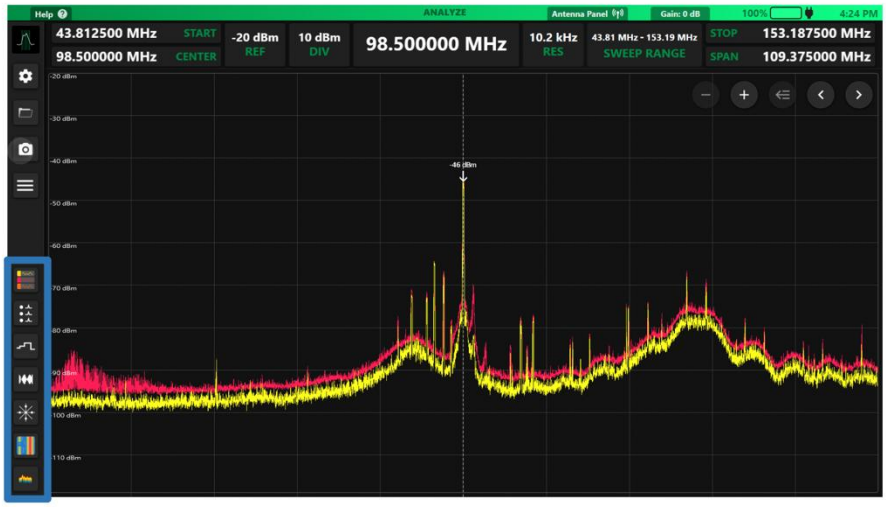


3) Toggle on the ***Mode Selector*** by tapping the current **Mode** icon (note that ***Mode-Specific Options*** are hidden while all mode icons become visible)

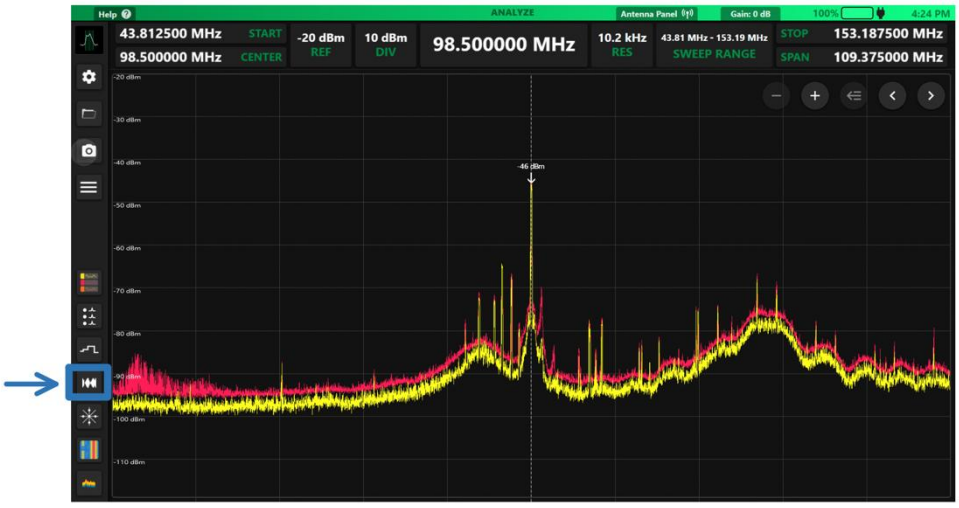
4) Select **Analyze Mode** by tapping on the icon



Analyze Mode  is now displayed, with the cursor (selected) frequency zoomed in on (regardless of span displayed in **Sweep Mode**). **Mode-Specific Options** are visible by default upon entering any mode.



5) Tap the **Demodulation** icon from the ***Mode-Specific Options***



Below the spectrum display, the **Demodulation** panel appears. Note the volume control button with volume level, off, and squelch options. The user should now hear the selected radio station.

Any signal selected by the cursor in Sweep Mode can be analyzed in Analyze Mode using the various Mode-Specific Options. These include Traces, Signal List, RSSI, IQ Recording, Raster Waterfall, and Persistence.

With the completion of this exercise, the user should be able to select a radio station in Sweep Mode, then switch to Analyze Mode to demodulate the signal and listen to the broadcast. They should also have been introduced to basic touchscreen display controls.

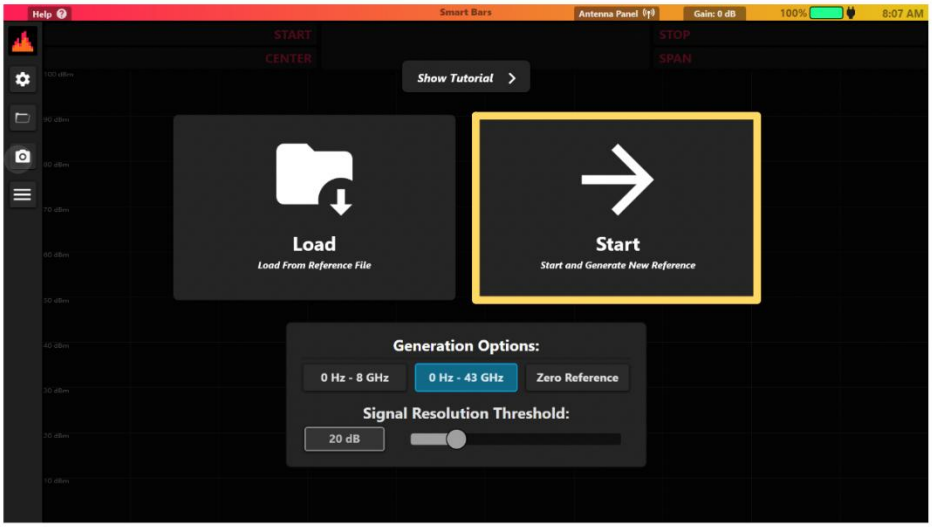
Exercise 2: SmartBars Mode

This exercise aims to introduce the user to SmartBars by detecting and locating a simulated threat device, generating a signal list, and saving it to an external drive.

For this exercise, a LoRa (from “long range”) Meshcore device is used. LoRa devices are low-power long-range radios that communicate in small-burst transmissions and can broadcast up to 5 kilometers (urban) or 15 kilometers (rural). They operate on unlicensed radio bands and make use of Chirp Spread Spectrum (CSS). These “chirps” can be detected in SmartBars mode.

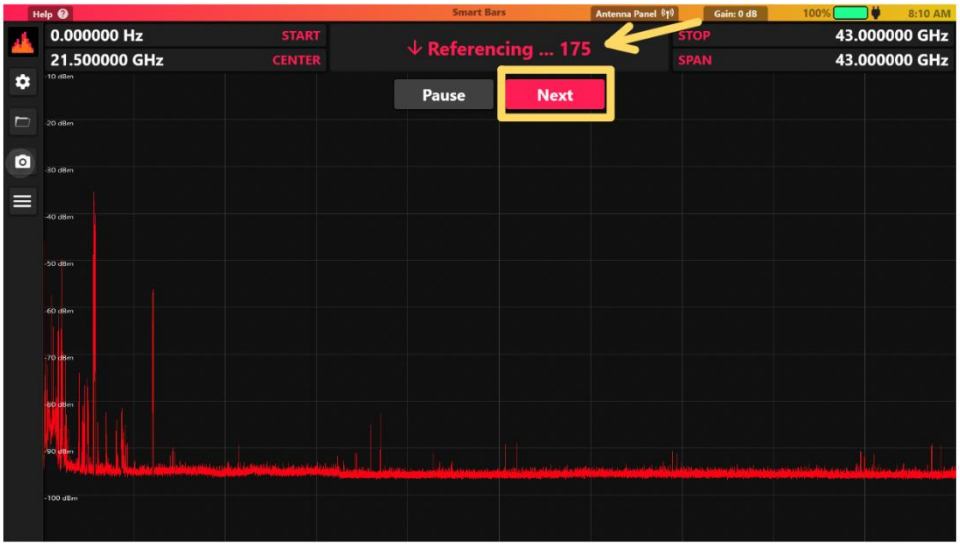
1) Select **SmartBars** mode (See p.4 for mode selection)

2) Select **Start** to collect a reference trace



Ideally, a reference trace is collected in the hallway or an adjacent room.

4) Allow ***Referencing*** for at least 5–10 minutes (an even longer reference can better eliminate expected signals), then select **Next**



SmartBars are shown on the display below. Red represents the peak signal power, and yellow represents the current signal power. Notice that the **Signal List** is empty, because no signals have crossed the threshold of -20 dBm.

5) Activate the LoRa transmitter (to simulate new RF energy)

Observe SmartBars — both the bar that is now above the threshold and the automatically generated signal list. Of the 30 bars covering the entire frequency span of 0 – 43 GHz, one contains the "threat signal," which was not present during the reference trace.

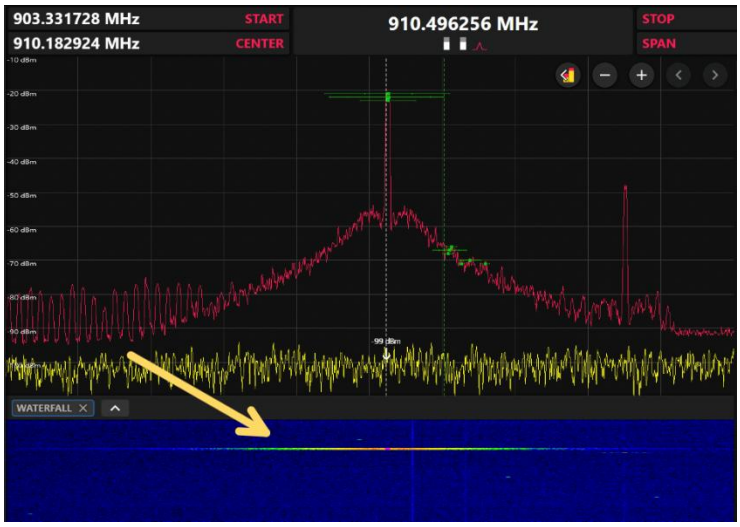
6) Double-tap the bar in the screenshot above

Again, note that the next set of SmartBars has divided the first bar's frequency span into 30 bars

7) Select the bar (above) by double-tapping it

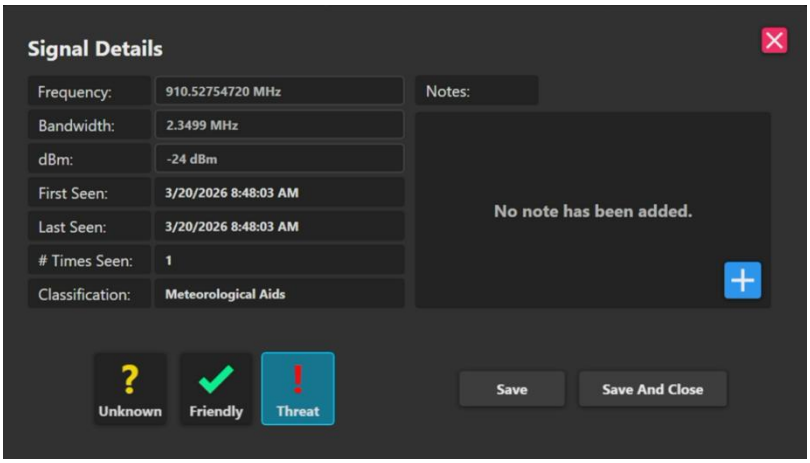
This will bring up the spectrum zoomed in on the signal. Use the display controls to pan the spectrum (if needed) and move the cursor to the signal. When viewing the spectrum through SmartBars, the Raster Waterfall automatically opens.

8) Use the LoRa device to again send an RF burst



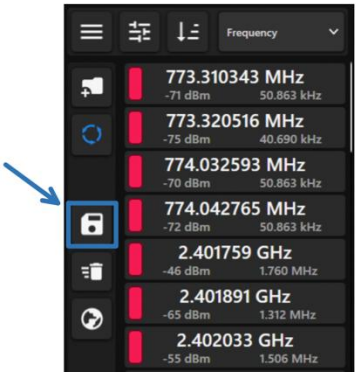
9) Observe the burst in the ***Raster Waterfall***

10) Double-tap the signal in the **Signal List** to bring up the ***Signal Details*** window



11) Add any notes, classification, or view details, then select **Save** or **Save and Close**

12) Save the signal list by selecting **Save As**



With the completion of this exercise, the user should be able to operate SmartBars and the Raster Waterfall to detect and locate a threat signal and then save the signal list. Saving a signal list is a feature in other Modes and operates similarly.

Exercise 3: Sweep Mode *(Introduction to Math Traces)*

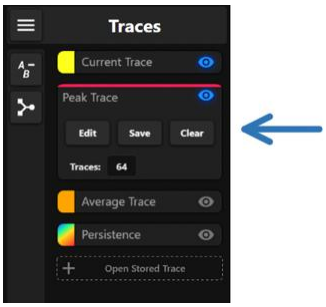
This exercise aims to introduce methods for detecting and locating a threat signal using Peak Traces, Math Traces, and the Raster Waterfall. In this example, a car key fob is used. This exercise makes the following assumptions:

- Two rooms are being compared: Office A and Office B
- The transmitter is located in Office A

1) If not already selected, enter **Sweep Mode** 
2) Open **Traces** from the ***Mode-Specific Options***

Observe the ***Traces Panel*** on the right side of the screen. On the display, there are yellow and red traces. These are the Current (yellow) and Peak (red) Traces.

3) Select **Peak Trace** in the ***Traces*** panel



This brings up three options: Edit, Save, and Clear. Note the sweep counter resets when **Clear** is pressed and immediately begins the sweep count again. The trace count keeps track of how many sweeps are counted in each **Peak Trace**.

4) Begin with Office B

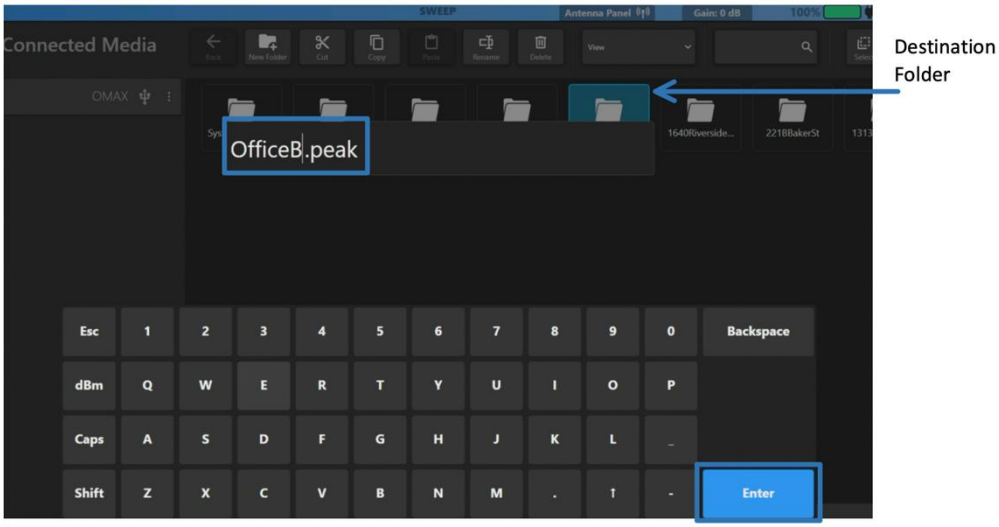
This room will be for the **Baseline Trace**. The **Baseline Trace** is intended to find expected signals in a neutral space. This space can be a nearby office, hallway, etc. It is not the space to be secured against threat signals (that will be Office A), but it should be nearby.

5) **Clear** the ***Peak Trace***

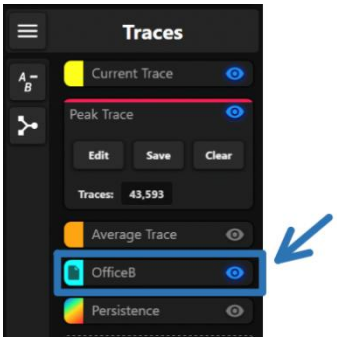
While the trace count begins each time the OSCOR Max is powered on, it is a good practice to clear the **Peak Trace** when beginning a sweep.

6) Allow the ***Peak Trace*** to collect signals

7) Save this ***Peak Trace*** by selecting **Save**
   a. Select or create the destination folder
   b. Name the file "OfficeB"
   c. Tap **Enter** and then **Save** to save the trace



Note that the Office B trace is now visible in the trace panel (and in the spectrum display).



8) Next, move to Office A

This is the room to be secured. Here will be the "threat" device — the car key fob.

9) Clear the ***Peak Trace*** again

10) While collecting signals, depress the key fob to generate a new “threat” signal

11) **Save** this ***Peak Trace*** by repeating Step #7, a – c, but label the trace as “OfficeA”

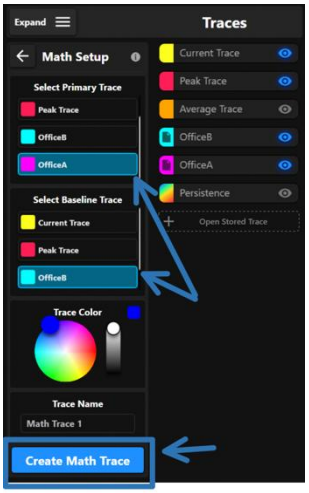
Note the Office A trace is also now visible in the traces panel.

12) Open the **Math Setup** by selecting the math icon

13) Select **Office A** trace as the ***Primary Trace***

14) Select **Office B** trace as the ***Baseline Trace***

15) Select **Create Math Trace**



Observe the lower window with the Math trace in blue. (When comparing Math traces, it may be easier to view the Peak and Current Traces by toggling off the Office A and Office B traces by tapping their eye  icons.)

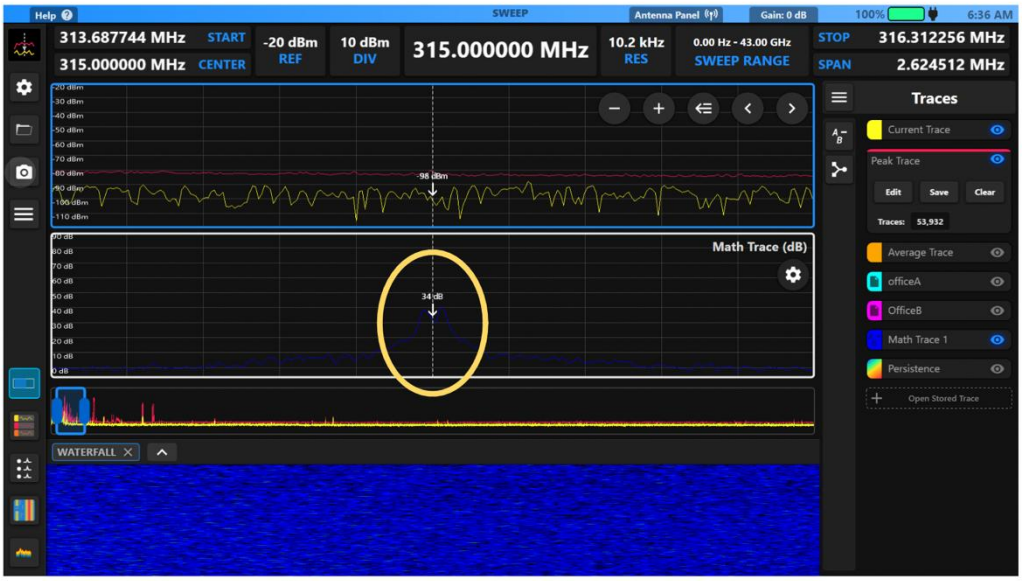
16) Clear the **Peak Trace** again

Observe and Compare the ***Peak Trace*** (and ***Current Trace***) with the ***Math Trace***. The expected signals from Office B have been subtracted from the Office A signals, leaving only potential threat signals to explore and locate (blue trace).

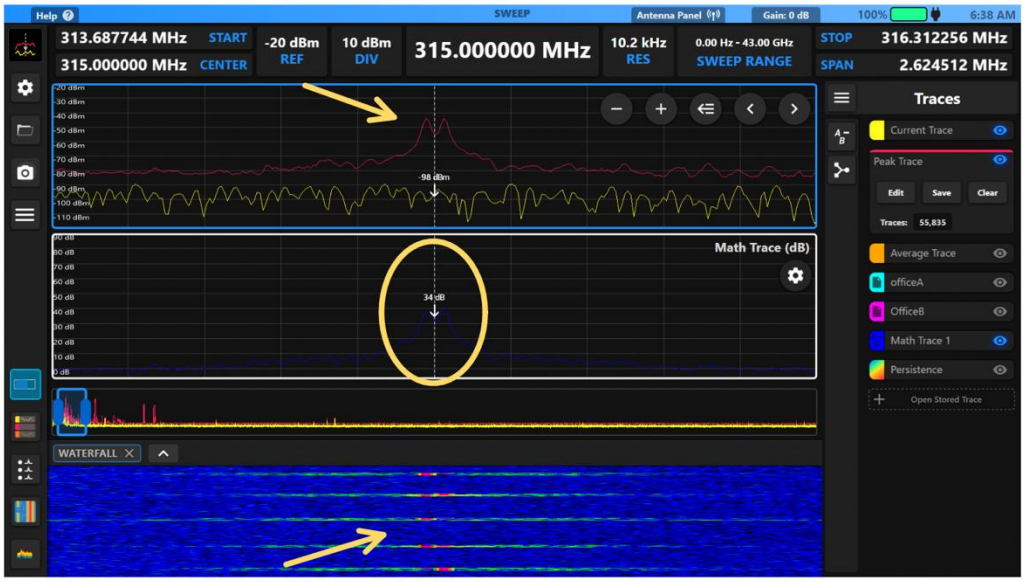
Using the pan buttons, Pinch-to-Zoom, swiping left/right, and zoom buttons, work through the spectrum until the key fob signal is found. (Hint: they are located at 315 MHz or 433 MHz for most cars. For this example, the signal is at 315 MHz.)

17) Move the cursor to the signal location and zoom in further

18) Open the **Raster Waterfall** ***Mode-Specific Option*** by tapping on the waterfall  icon



19) Press the key fob's button a few times



Watch as the signal appears in the ***Raster Waterfall*** and note that the signal also appears in the ***Peak Trace.*** The ***Raster Waterfall*** is an effective search tool when locating a potential threat device. When nearing the signal source, the size and color of the signal will indicate increasing proximity.

After completing this exercise, the user should be able to create a math trace and use it to find potential threat signals and locate them using the Raster Waterfall.

Exercise 4: WiFi Mode

This exercise familiarizes the user with WiFi Mode by detecting and locating a cellular phone. WiFi Mode detects and lists nearby WiFi signals at 2.4 GHz, 5 GHz, and 6 GHz, with classifications by type, SSID, Manufacturer, Frequency, dBm, and Channel numbers. The user can then select a device to view further details (Focus) and locate it using the RSSI histogram and bar.

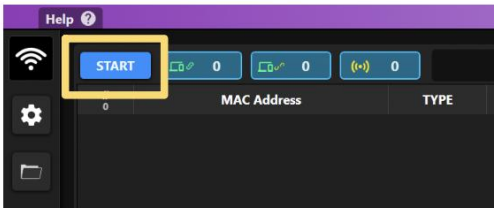
1) Set the phone's WiFi MAC address to **Device MAC** (or **Fixed** for Apple phones) instead of *Randomized/Rotating*, and make note of the 12-digit hexadecimal number

   In this exercise, the example cellular phone's WiFi MAC address is: ***FE:AE:6E:72:34:9A***

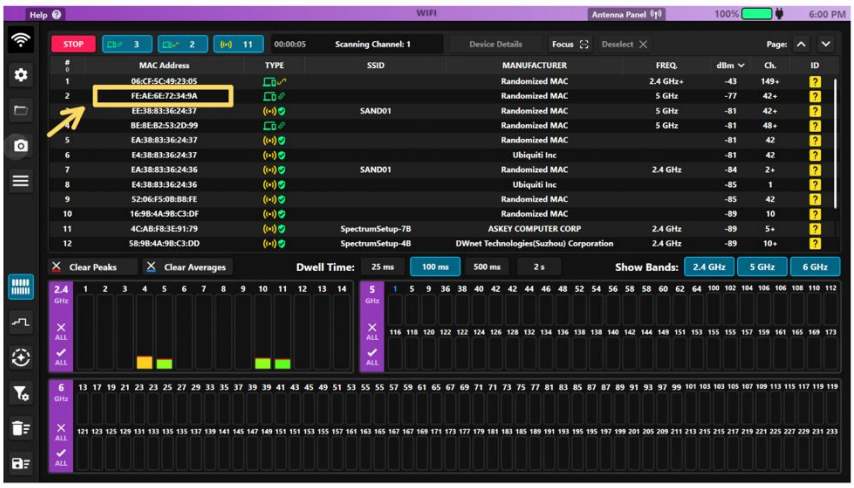
2) Stream video with the phone (over WiFi)

3) Select **WiFi Mode** (see p.4 for mode selection)

4) Press **Start** to begin collecting WiFi signals

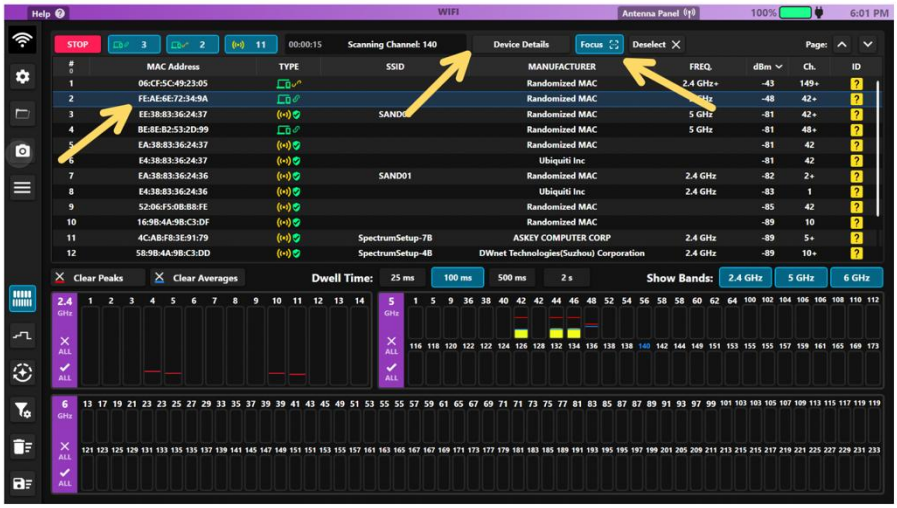


5) Locate the device's WiFi MAC address in the list



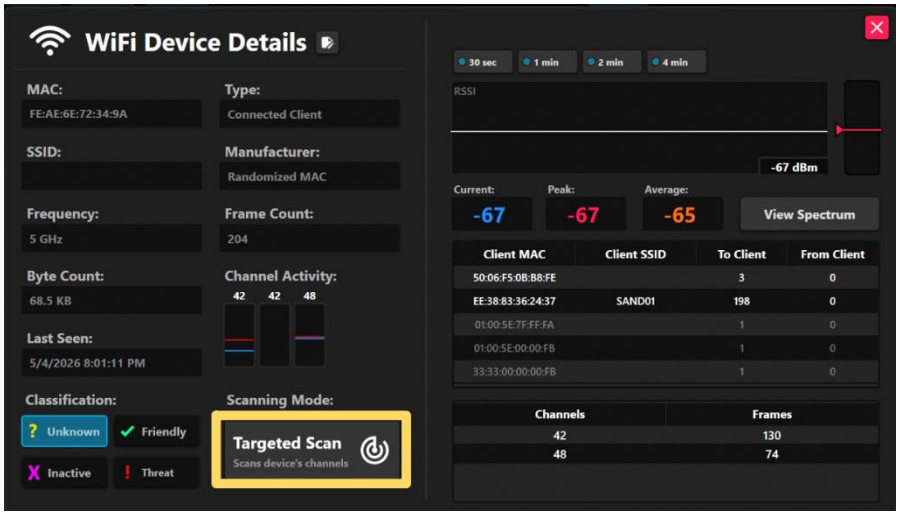
Notice the list has columns for (number) #, MAC Address, Type (Access Point, Client, and Secure/Non-Secure), SSID, Manufacturer, Frequency, Power (dBm), Channel, and ID (awaiting user input). At the top, there are options to view Device Details, Focus, and Deselect.

6) Tap on the device to select it within the list to highlight it



7) Observe that the Focus option is now highlighted. (The device can be deselected by tapping **Deselect**.)

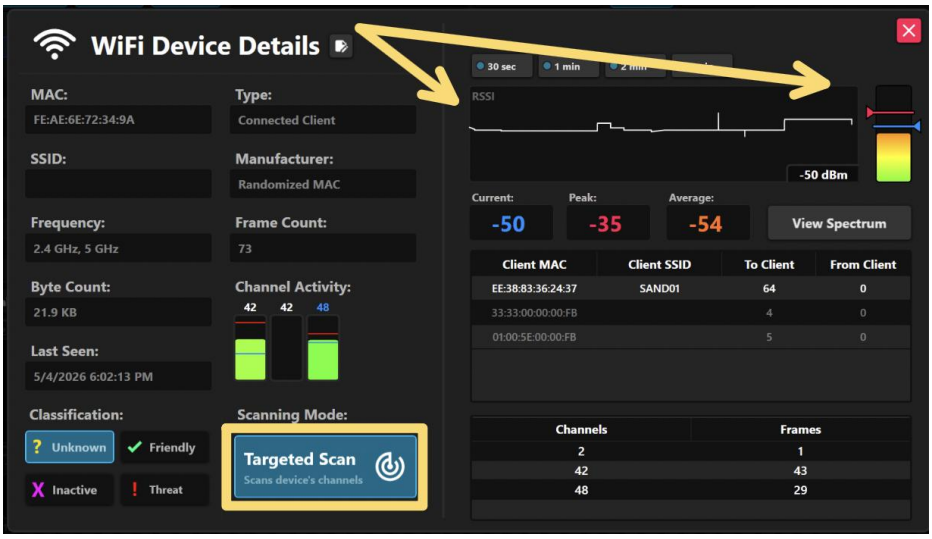
8) Tap on **Device Details** to bring up the detail window



The Device Details window contains additional information and allows the user to classify the device.

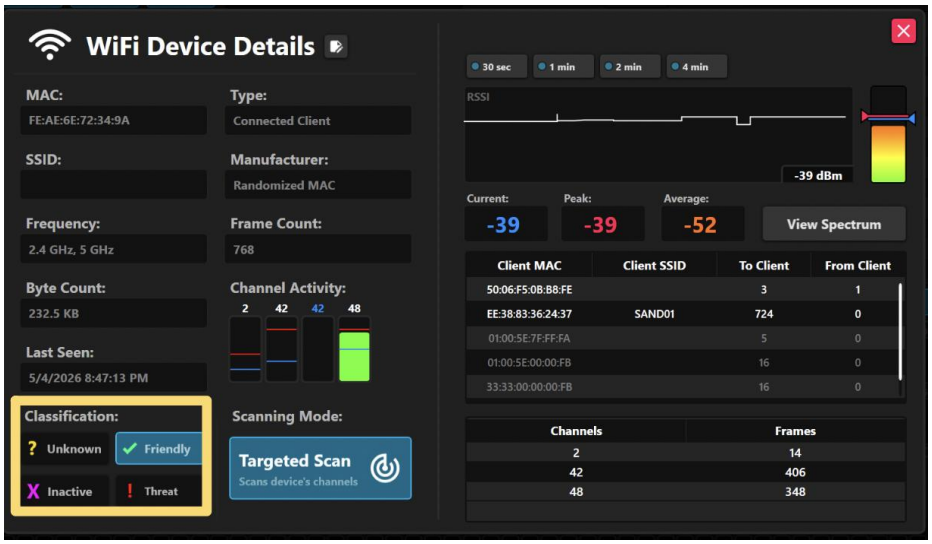
9) Tap **Targeted Scan** to exclusively scan the device

10) Use **RSSI** to locate the device



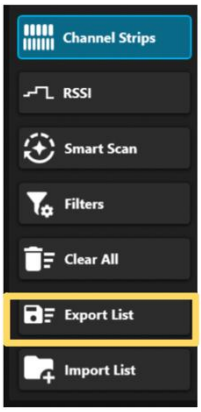
With ***Targeted Scan*** enabled, the OSCOR Max will scan only the selected device's signal.

11) Classify the device as Friendly (or Inactive, Threat)



The classification will also appear in the list view's ID column.

12) Save the list by selecting **Export List** (see p.15 for detailed instructions)



13) Return phone settings to Randomization and/or Rotating to restore privacy

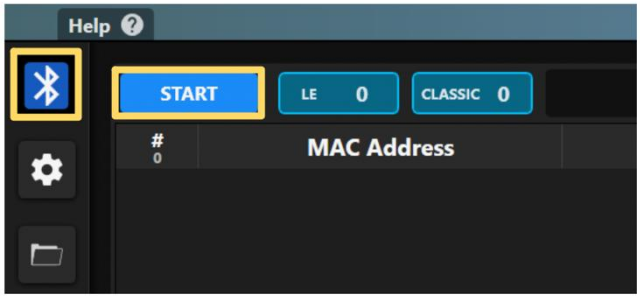
This exercise walks the user through steps to generate WiFi traffic, recognize the device in the list, and use RSSI to locate it. They will also be able to classify the device and save the list to an external device. In a real-world scenario, the user would work through the list of WiFi signals to locate and classify them and might compare them with a list of expected MAC addresses.

Exercise 5: Bluetooth Mode

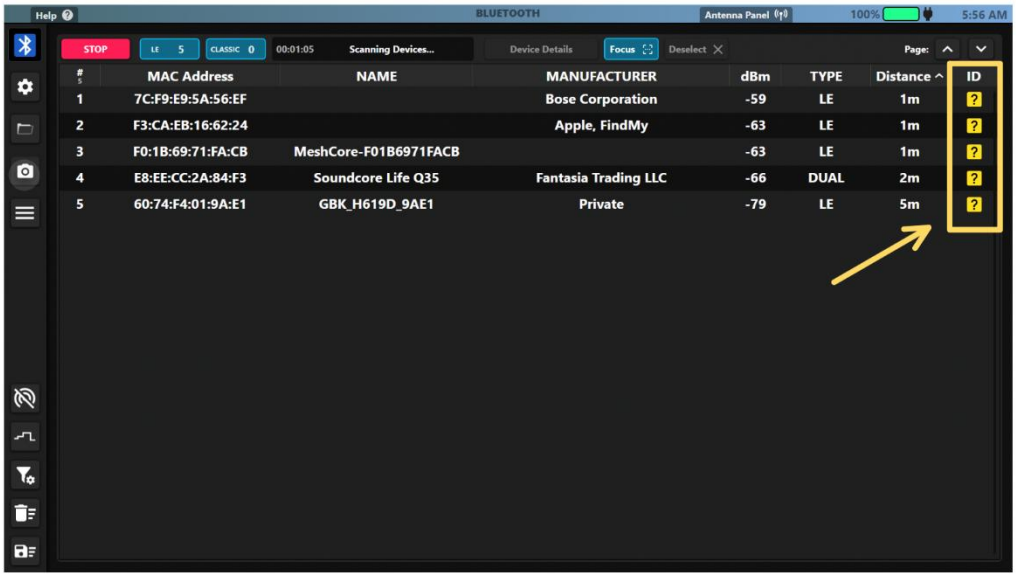
This exercise will introduce the user to Bluetooth Mode by detecting and locating a wireless Bluetooth earbud device. Bluetooth Mode collects signals for both LE (Low Energy) and Classic devices.
Note: Some Bluetooth devices that are paired and encrypted might not be detectable with Bluetooth Mode.

Begin by ensuring the earbuds are charged, unpaired, and not in pairing mode (usually in a closed case)

1) Enter ***Bluetooth Mode***  (see pages 4 and 6)
2) Press **Start**



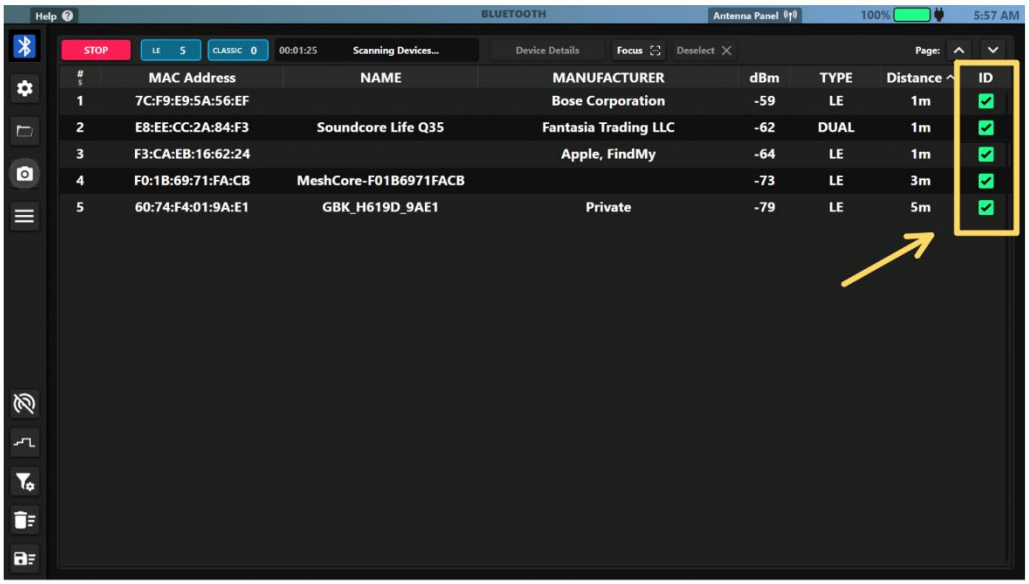
3) Allow the OSCOR Max to find and list all nearby Bluetooth devices (1-2 minutes)
4) Press **Stop**



Note the device list contains the following columns: Number, MAC Address, Name (when available), Manufacturer, Power (dBm), Type, Distance, and ID. The ID column is for user-determined classification. A single tap on the device's ID will change it from *Unknown* to *Friendly*, then to *Inactive,* and finally to *Threat*. (These options are also available in the Device Details window.)

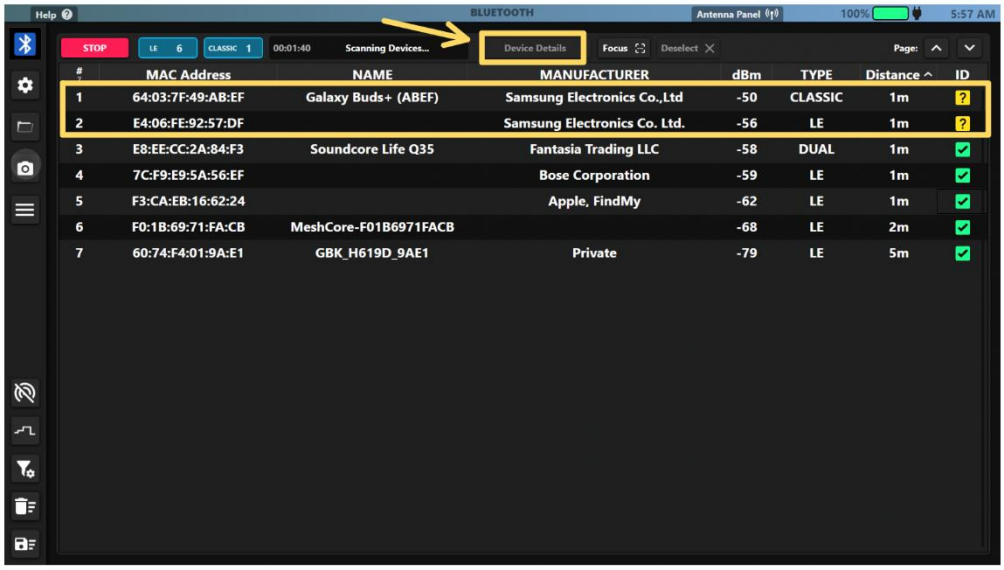
For this next step, assume these devices are expected signals. In a real-world environment, these signals would need to be explored before labeling as friendly.

5) Label all signals as ***Friendly*** with a single tap on each one (in the **ID** column)



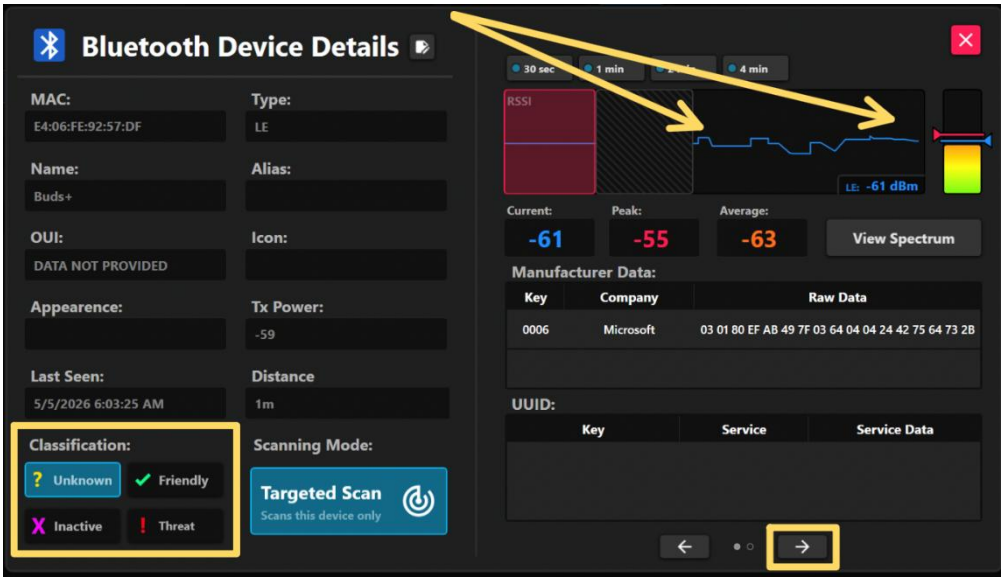
6) Place the earbuds in pairing mode

7) Press **Start** to continue collecting signals



Note the appearance of the earbud device and that it is labeled **Unknown**. In this instance, the new Bluetooth Device will show up as both a Classic and LE device because it is broadcasting as both.

8) Tap on the device within the list to highlight it, and then press **Device Details**

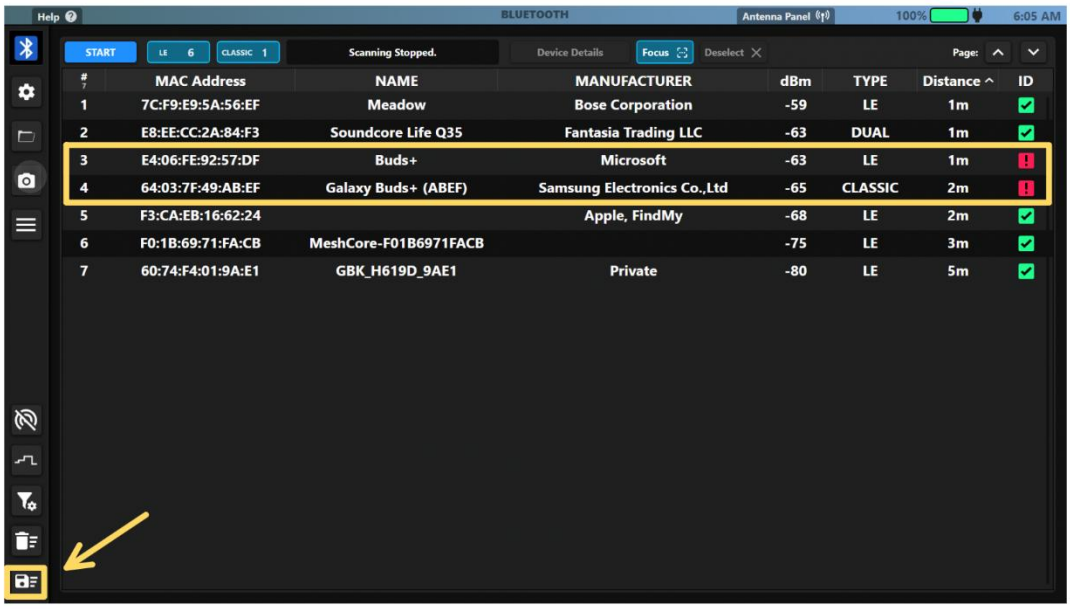


This device detail window contains additional information about the device. Additional Manufacturer Data is available with the selection of the arrow located at the bottom right. Note that Targeted Scan is highlighted. The scan is targeted only to this selected device.

9) Locate the device by using the **RSSI** graphs (histogram and bar)

10) For this exercise, label the device as **Threat**

11) Close the window by pressing **X**



Observe that the list now contains devices previously labeled as Friendly, as well as the newly found “threat” device.

12) Select **Save All** to save the list

After this exercise, the user should be able to use the basic features of Bluetooth Mode. They can now detect, locate, and classify a Bluetooth device, as well as save the list for future reference and reports.

Exercise 6: Discrete Bands Mode

This exercise will introduce the user to the Discrete Bands Mode and some of its features by detecting and locating a temperature sensor. For this exercise, the temperature sensor broadcasts at around 433 MHz and sends a burst approximately every 1 minute and 20 seconds.

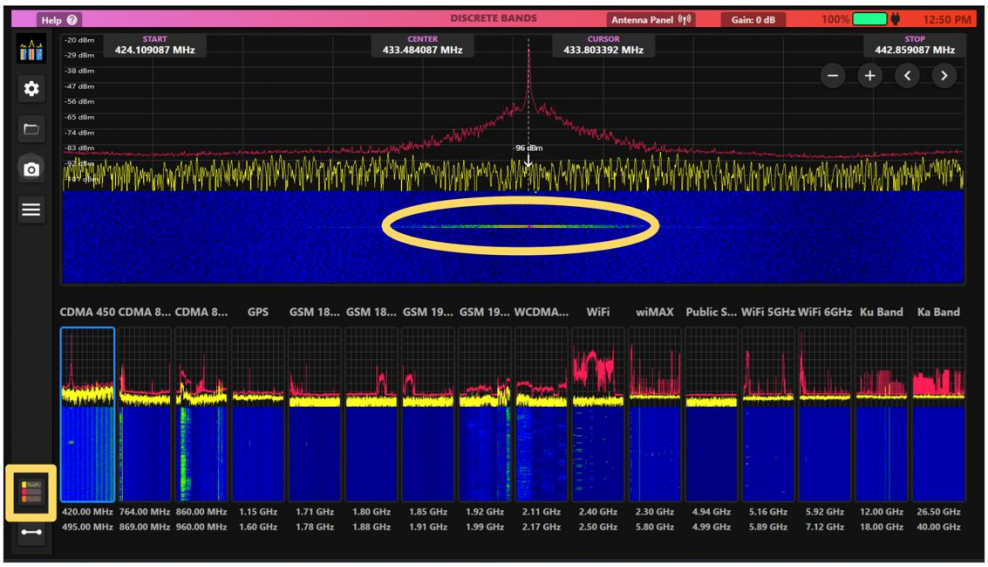
Note that the screen is divided into two halves: the top will display the full view of the user-selected band, while the bottom will display all 16 preset bands. Bands can be selected with a single tap.

1) Enter **Discrete Bands Mode**  (see p.4)
2) Power the device and place it in the environment to be monitored

Observe that in this exercise, the left-most band (frequency range 420-429 MHz) contains the signal from the temperature sensor.

3) If the band is not selected and highlighted, tap on the band to highlight it
4) Center the cursor on the signal peak and then zoom in

5) Observe the Waterfall, both in the band display and the spectral display above it
Watch for the device to send another burst signal and for it to appear in the waterfall

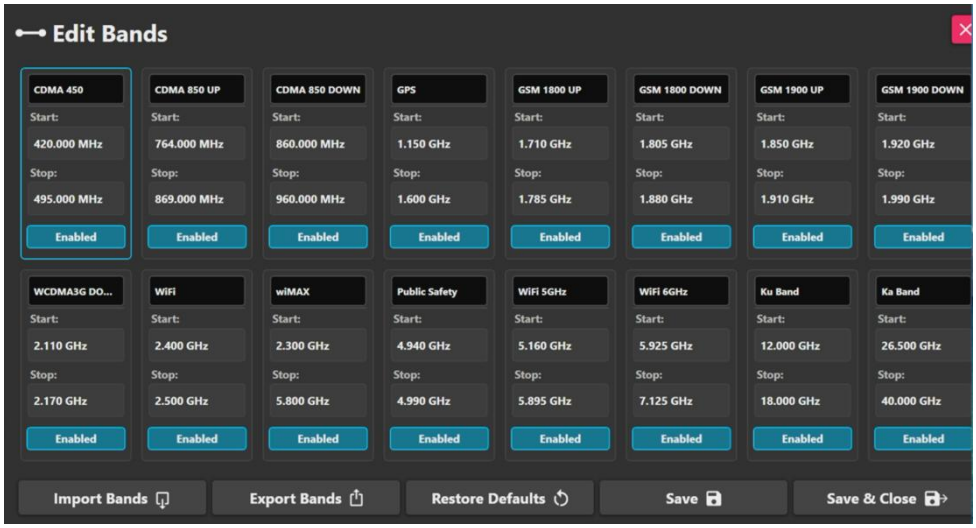


6) Open the **Traces** panel with a tap (button highlighted above)

7) Tap **Clear** to clear all peaks (button highlighted above)

If desired, continue to observe the temperature sensor's burst signal and note its appearance. Burst devices should have an intermittent and consistent appearance in the Waterfall. Atypical behavior of a burst device can indicate a security issue.

8) Tap **Edit Bands** to open the option



The ***Edit Bands*** window allows the user to edit bands and then save them. They can also choose to import previously saved bands or export the edited bands for future use.

With this exercise, the user has been introduced to the Discrete Bands mode, observed a burst device in the band (spectrum and waterfalls), and observed the Edit Bands features.

Modes, Mode-Specific Options, and General Options

Mode Selector

The **Mode Selector** provides access to all modes. To bring it up, tap the current mode icon. The ***Mode Selector*** is hidden when entering a new mode or upon powering on, and instead displays the ***Mode-Specific Options***. (See p.4)

Modes

Sweep 

Sweep Mode is the default mode at power-up. It sweeps the full spectrum between 10 kHz and 43 GHz. It has tools to pan, zoom, center, or directly enter a specific frequency. At the top of the screen is the Spectral Display, containing information about the displayed range. Mode-Specific Options are the following: Detail Zoom, Traces (including Math Setup), Signal List, Raster Waterfall, and Persistence.

Sweep Screen

The default screen is split into two. The first (top) covers 0 – 8 GHz and the second (middle) covers 8 – 43 GHz. The bottom bar displays the full spectrum with a Detail Zoom window. To expand the window, click the handles and drag. The entire window can also be moved left and right. Modifying detail zoom, using the zoom in/out buttons, or pinch-to-zoom will expand the selected split-screen to expand and fill the space. The full-spectrum bar remains. To return to the split-screen covering the full spectrum, press the button highlighted in yellow.

Analyze 

Analyze Mode presents the user with their selected signal (centered and zoomed in) when switching from Sweep Mode. The tools for display control are the same as those found in Sweep Mode. Mode-Specific Options are: Traces, Signal List, RSSI, Demodulation, IQ Recording, Raster Waterfall, and Persistence.

WiFi 

WiFi Mode scans for 2.4 GHz, 5 GHz, and 6 GHz signals. The Signal List displays each device by MAC (Media Access Control) address along with information on Type, SSID (Service Set Identifier) Number, Frequency, dBm, Channel, and ID. Signals can be selected for analysis with a double-tap, which pulls up the WiFi Device Details window, with further details and an RSSI bar graph. Mode-Specific Options are Channel Strips, RSSI, Smart Scan, Filters, Clear All, and Save All.

Discrete Bands 

Discrete Bands Mode displays preset frequency ranges — bands commonly used for cellular, GPS, WiFi, etc. They are editable via the Mode-Specific Option, *Edit Bands*. The Traces panel is also available as a Mode-Specific Option.

Bluetooth 

Bluetooth Mode scans for both Classic and LE (Low Energy) devices. The device list includes the MAC Address, Name (when available), Manufacturer, dBm, Type, Distance, and ID. To see additional details of the device, a double-tap (after stopping the scan) will bring up the Bluetooth Device Details window. This contains additional details, classification, RSSI bar graph, and View Spectrum. The Mode-Specific Options are Passive Mode, RSSI, Filters, Clear All, and Save All.

SmartBars 

SmartBars Mode provides a quick and easy method to detect unexpected signals in an area to be secured. A reference trace eliminates expected signals from the environment and only shows the remaining signals indicated by bars (showing peak and current signals, see Exercise 2, p.11). The Signal List is automatically generated and comes with Threshold and other controls, as well as options for saving. The Mode-Specific options are Signal List, Alerts, Clear SmartBars, Save Reference, Edit Threshold, and Restart SmartBars.

Spectrogram 

Spectrogram Mode captures a series of traces and displays them in a waterfall format. This records the RF spectrum over a period of time to easily identify intermittent transmissions such as burst transmitters. Before waterfall recording begins, there are options for setting the Start/Stop Frequency Range, Record Duration, Peak Interval, and Schedule. The recording is saved to the hard drive (removable) and can be transferred to the user's USB device using the File Explorer. Mode-Specific Options are Traces, Signal List, RSSI, and Stop Recording. (This feature will be coming in a future software release.)

General Options

These features are always visible in the display.

 **Settings** — General, Storage, Theme, About, ITU Regions

 **File Explorer** — Hard Drive, User Storage Device

 **Screenshot** — tap to capture a screenshot of the current display with prompts to save

 **Expand Menu** — tap to expand menu items to include names

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This Quick-Start Guide is intended to introduce the OSCOR Max Spectrum Analyzer and its basic uses and features. A full User Manual is forthcoming. Check with REI for availability.

This Quick-Start Guide contains proprietary information intended solely for use with the OSCOR Max.

REI offers training courses that include classroom instruction and hands-on exercises. The progressive course curriculum is designed for the beginner or the seasoned Technical Security Technician. Regularly scheduled courses are taught monthly — visit REI's website (www.reiusa.net) or contact REI (sales@reiusa.net) for training dates.

The Serial Number of each OSCOR Max is located on the back of the unit. Please record this number and refer to it whenever you contact your dealer or Research Electronics International concerning this product. Note: Removal or alteration of the serial number automatically voids all warranties of this product.

SERIAL NUMBER: _____