



Quick Start & Application Guide


1. Starting the AudioExpert System (Sodera and BPA 600 only)

To use the Audio Expert System™, the user must have

- Current Premium Maintenance purchased from Frontline
- Frontline hardware, with Audio Expert System™ license installed, connected to the PC. This is a requirement for both live capture and when viewing a saved capture file.

For live capture, set up the Frontline Sodera or Frontline BPA 600 datasource and begin capturing data.

For viewing a capture file, load the saved file from the **Control** window **File** menu.

When an audio stream is available the open the **Audio Expert System™ Window** by clicking on the **Control** window Audio Expert System™ button . If the Frontline hardware is not licensed for Audio Expert System™, the button will not be present.

2. Audio Expert System™ Window

This window is the working space for the Audio Expert System™. Upon opening Audio Expert System™ the window shown below will open with four main areas displayed :

- Global Toolbar - Provides play cursor controls, waveform viewing controls, and volume controls that affect all Wave Panels.
- Wave Panel - Displays the waveforms for each captured audio stream. There is a separate Wave Panel for each stream. Each panel contains local information, controls, and an event timeline specific to the displayed audio stream being shown. Other Wave Panels that may be off screen may be viewed using the vertical scroll control or by collapsing other Wave Panels.
- Event Timeline - The Event Timeline shows *Bluetooth* events, Codec events, and Audio events synchronized to the displayed waveform. There is an Event Timeline in each Wave Panel.
- Event Table – A tabular listing of *Bluetooth*, codec, and audio events with information on event severity, related *Bluetooth* frame, timestamp, and event information.

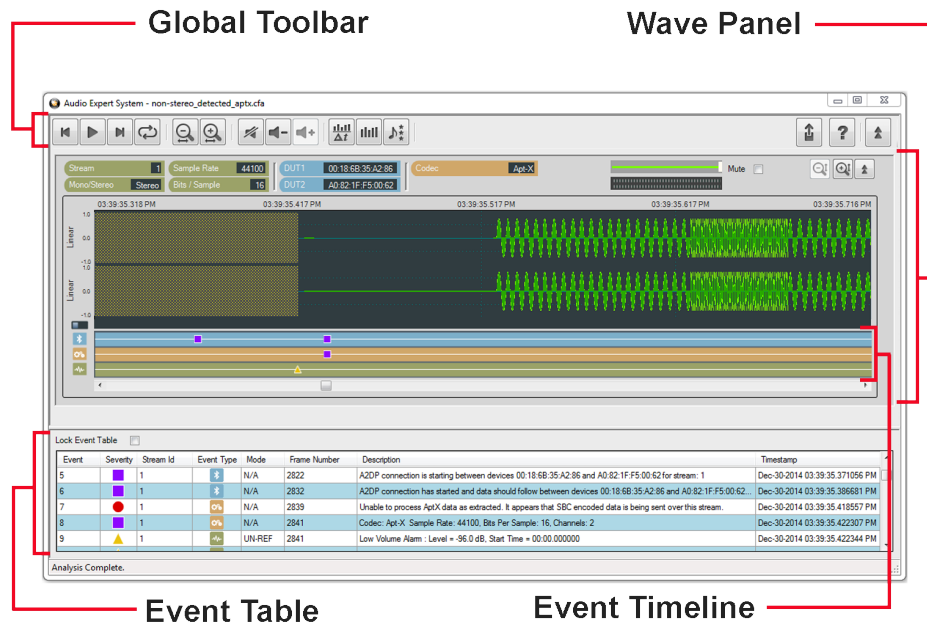


Figure 1 - Audio Expert System™ Window

3. Wave Panel

The Stream Panel is where the details of the captured audio stream are presented. The Stream Panel displays the captured audio waveform along with an event timeline that displays discrete *Bluetooth*, *Codec*, and *Audio* events synchronized to the captured waveform. .

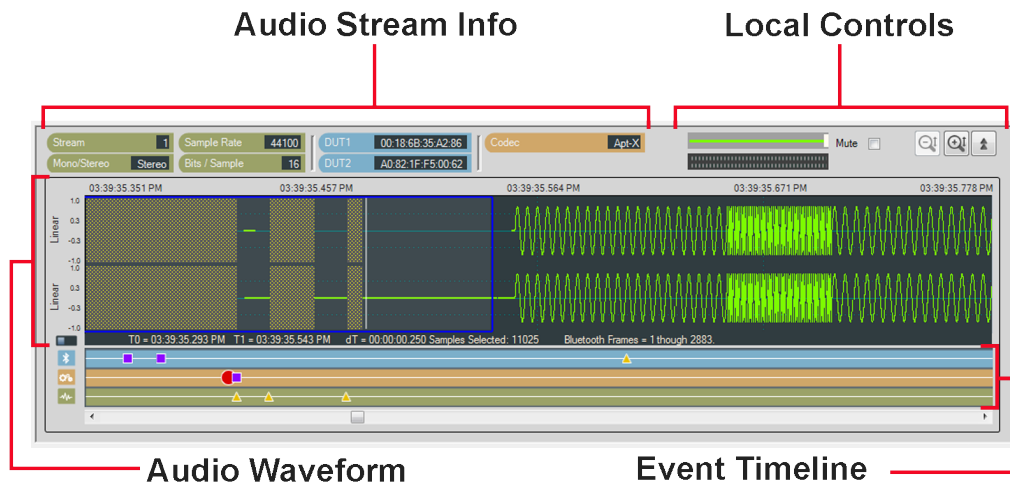





Figure 2 - Wave Panel

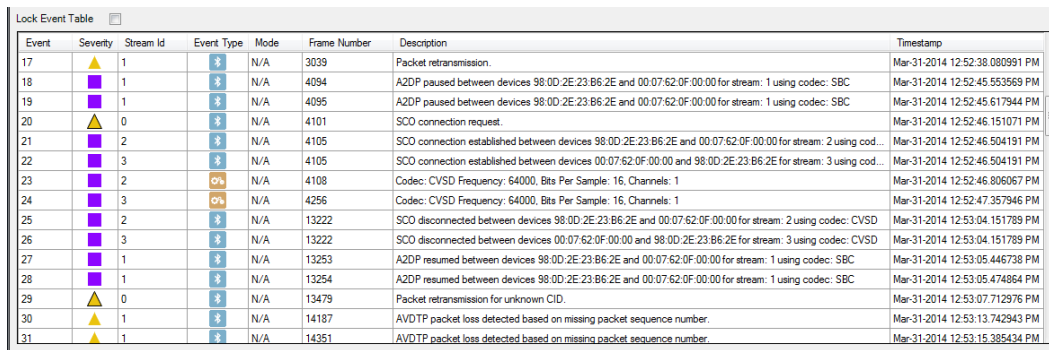
The Wave Panel contains four sections.

1. Audio Stream Info that provides users with information, such as sample rate, bit/sample, codec and DUT (Device Under Test) addresses.
2. Local Controls include audio volume controls and Indicators, “Mute”, “Vertical Zoom” and “Collapse/Expand”

- An Audio Waveform which is plotted as amplitude (linear or dB) versus time and an interactive play cursor. The play cursor appears as a white vertical line across the waveform.
- Event Timeline that shows color coded *Bluetooth* , *Codec* , and *Audio*  events. Details of these events are listed in the Audio Expert System™ Event Table.

4. Event Table

The Event Table lists all audio stream events. Clicking on an event will select that event in the Event Timeline in the Wave Panel. If the selected event is outside the visible area of the waveform, the waveform will move and bring the selected event to the center of the display. The event icon in the Event Timeline is also centered and the selected icon will be larger than the non-selected event icons. Selecting one or more events in the table will highlight the associated frames in the standard Frontline software windows, such as **Frame Display**, **Coexistence View**, **Bluetooth Timeline**, etc. .



Event	Severity	Stream Id	Event Type	Mode	Frame Number	Description	Timestamp
17	Warning	1	Bluetooth	N/A	3039	Packet retransmission.	Mar-31-2014 12:52:38.080991 PM
18	Information	1	Bluetooth	N/A	4094	AZDP paused between devices 98:0D:2E:23:B6:2E and 00:07:62:0F:00:00 for stream: 1 using codec: SBC	Mar-31-2014 12:52:45.553569 PM
19	Information	1	Bluetooth	N/A	4095	AZDP paused between devices 98:0D:2E:23:B6:2E and 00:07:62:0F:00:00 for stream: 1 using codec: SBC	Mar-31-2014 12:52:45.617944 PM
20	Warning	0	Bluetooth	N/A	4101	SCO connection request.	Mar-31-2014 12:52:46.151071 PM
21	Information	2	Bluetooth	N/A	4105	SCO connection established between devices 98:0D:2E:23:B6:2E and 00:07:62:0F:00:00 for stream: 2 using cod...	Mar-31-2014 12:52:46.504191 PM
22	Information	3	Bluetooth	N/A	4105	SCO connection established between devices 00:07:62:0F:00:00 and 98:0D:2E:23:B6:2E for stream: 3 using cod...	Mar-31-2014 12:52:46.504191 PM
23	Information	2	Codec	N/A	4108	Codec: CVSD Frequency: 64000, Bits Per Sample: 16, Channels: 1	Mar-31-2014 12:52:46.806067 PM
24	Information	3	Codec	N/A	4256	Codec: CVSD Frequency: 64000, Bits Per Sample: 16, Channels: 1	Mar-31-2014 12:52:47.357946 PM
25	Information	2	Bluetooth	N/A	13222	SCO disconnected between devices 98:0D:2E:23:B6:2E and 00:07:62:0F:00:00 for stream: 2 using codec: CVSD	Mar-31-2014 12:53:04.151789 PM
26	Information	3	Bluetooth	N/A	13222	SCO disconnected between devices 00:07:62:0F:00:00 and 98:0D:2E:23:B6:2E for stream: 3 using codec: CVSD	Mar-31-2014 12:53:04.151789 PM
27	Information	1	Bluetooth	N/A	13253	AZDP resumed between devices 98:0D:2E:23:B6:2E and 00:07:62:0F:00:00 for stream: 1 using codec: SBC	Mar-31-2014 12:53:05.446738 PM
28	Information	1	Bluetooth	N/A	13254	AZDP resumed between devices 98:0D:2E:23:B6:2E and 00:07:62:0F:00:00 for stream: 1 using codec: SBC	Mar-31-2014 12:53:05.474864 PM
29	Warning	0	Bluetooth	N/A	13479	Packet retransmission for unknown CID.	Mar-31-2014 12:53:07.712976 PM
30	Warning	1	Bluetooth	N/A	14187	AVDTP packet loss detected based on missing packet sequence number.	Mar-31-2014 12:53:13.742943 PM
31	Warning	1	Bluetooth	N/A	14351	AVDTP packet loss detected based on missing packet sequence number.	Mar-31-2014 12:53:15.385434 PM

Figure 3 - Event Table

Several events can be selected by clicking and dragging over the events, or by holding down the Shift key and clicking on events. To select events that are not adjacent hold down the Ctrl key and click on the events.

When selecting multiple events, the Wave Panels will not scroll to the selected events.

The Event Table contains eight columns.

Table 1 - Event Table Columns







Name	Value	Description
Event	integer	System generated sequential numbering of events.
Severity		Information - provides information of interest but does not indicate a problem event.
		Warning - identifies a potential problem where further investigation may be appropriate
		Error - identifies a definite problem.
Stream Id	integer	A system generated ID that is assigned in the order that the audio streams are detected. The ID is not maintained between captures for the same device with the same audio. It identifies the Wave Panel where the event can be viewed. The ID appears in the Audio Stream Info of the Wave Panel.
Event Type		<i>Bluetooth</i> -Events generated by analyzing Bluetooth protocol activities.

Table 1 - Event Table Columns (continued)

Name	Value	Description
		Codec -Events generated from analyzing the audio coding/decoding activities.
		Audio -Events generated by analyzing the audio data.
Mode	N/A	Mode does not apply to this event.
	REF	Referenced Mode..
	UN-REF	Non-Referenced Mode. .
Frame Number	integer	The system generated identification for a specific frame.
Description		Details and explanation about this event.
Timestamp	clock date and time	A system generated time stamp for each frame.





Sorting

Event table entries are sortable by column. Left-click on the column heading to sort.

Event Table Pop-Up Menu

Right-clicking with the cursor over the Event Table will open a menu of additional options.

Lock Event Table

Event	Severity	Stream Id	Event Type
17		1	
18		1	

The **Lock Event Table** checkbox is available in live mode only. Clicking to check the box will prevent the Event Table from scrolling during live capture. Un-checking the box will resume scrolling of events as they are detected. When analyzing a capture file the checkbox has no effect.

5. Wave Panel & Event Table Pop-up Menu

Additional Wave Panel and Event Table options are available by right clicking the mouse with the cursor anywhere in the Wave Panel or in the Event Table.

Wave Panel Pop-up Menu Actions

Right-clicking anywhere in the Wave Panel will provide you with a selection of the following actions.

Table 2 - Wave Panel Pop-up Menu Selections

Option	Description
Clear Selection	Clears the current selection in the viewer
Copy Selection	Saves a copy of the selection to the computer clipboard. The clipboard can be pasted into a Word document, an e-mail, or other Windows clipboard-compatible application.

Table 2 - Wave Panel Pop-up Menu Selections (continued)

Option	Description
Export Audio Data	Opens the Export pop-up menu with options to export the waveform as a .raw, .wav, or Event Data.
Loop	Loops through the audio selected on the Wave Panel.
Zoom to Selection	Expands or compresses the selection to fill the Wave Panel view.
Select Area	When the mouse cursor is positioned over data (not fill, pause, or gaps) in the Wave Panel and selecting this option will select all the data between and fills, pauses, or gaps.
Select All	Selects the entire waveform

Event Table Pop-up Menu Actions


Right-clicking in the Event Table will provide you with a selection of the following actions.

Table 3 - Event Table Pop-up Menu Selection

Options	Description
Copy	Copies the selected events to Windows clipboard as text.
Clear Selection	Clears the current event selection in the table
Export Event Table	Copies the current event selection and saves it as a .csv file.
Loop	Loops through the audio selected on the Wave Panel.
Zoom to Selection	Expands the Event Table selection to fill the Wave Panel view.
Select Area	Expands the selection.
Select All	Selects all events.

6. Export Audio Data

There are two ways to export audio data:

1. Clicking the Audio Expert System™ window **Global Toolbar** Export button  .
2. Right-click in a Stream Panel Wave Panel and a pop-up menu will appear. Select **Export** .

Two windows will appear:

1. The standard Windows Save As.
2. The **Export Audio Data** dialog.

In the Windows Save As window enter a **File name** and directory location. Click on **Save**.

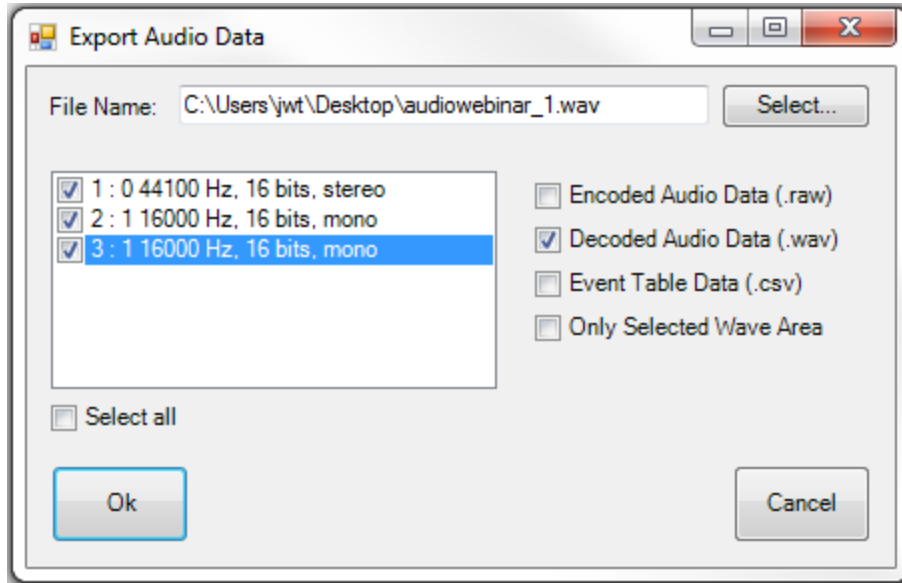


Figure 4 - Export Audio Data dialog

The Save As window will close, and the file name will appear in the **File Name** field in the **Export Audio Data** window. Should the file name need to be changed, click on the **Select** button and the Windows Save As dialog will open. By default the .wav file extension is used in the file name.





In the window below **File Name** will appear a list of **Stream IDs** with a description from the Audio Stream Info . If opening from the Audio Expert System™ **Global Toolbar** all **Stream IDs** are checked by default. If opening from a Wave Panel, the **Stream ID** where the export dialog was opened is automatically checked. You can check each stream that is to be exported. For convenience checking **Select all** below the stream list window will place checks in all streams.

Export Options

After selecting the streams to export, select the desired formats to export.

Table 4 - Export Audio Data Format Options

Option	Description
Encoded Audio Data	Exports the selected files as .raw format. The audio data is in an encrypted format and user will need a codec to decode it.
Decoded Audio Data	Exports the selected files as .wav format that can be played on a wide variety of media players.
Event Table Data	Exports a text .csv file of all the detected events
Only Selected Wave Area	Exports the Encoded, Decoded, or Event Data for the selected waveform. This option is only active if a selection has been made in one of the Wave Panels

	audiowebinar_1.csv	39 KB	Microsoft Excel C...
	audiowebinar_1.raw	5,439 KB	RAW File
	audiowebinar_1.wav	38,652 KB	Wave Sound
	audiowebinar_2.csv	39 KB	Microsoft Excel C...
	audiowebinar_2.raw	299 KB	RAW File
	audiowebinar_2.wav	7,227 KB	Wave Sound

Click on **OK** to save the waveform. The dialog will close and a series of progress bars will appear. Each progress bar is associated with a file for each export option. The exported files will have the following syntax: `<filename>_n.<filetype>`, where `<filename>` = the name entered into the File Name field, `n` = the stream id number (1, 2, 3, ...), and `<filetype>` = "raw", "wav", and "csv". The image shows an example where the user exported **Stream Id's** 1 and 2 in Encoded Audio, Decoded Audio, and Event Table data to filename "audiowebinar".

Click on **Cancel** to close the window without exporting.

7. Frame, Packet, and Protocol Analysis Synchronization

The Audio Expert System™ module integrates seamlessly with Frontline software with common timestamping of *Bluetooth* protocol data, audio events, audio waveform display, and codec events. The audio expert data and results are synchronized and coordinated with the existing Frontline software data views, such as **Frame Display**, **Bluetooth Timeline**, etc. to expedite the root-cause analysis of *Bluetooth* protocol related audio issues. When a frame is selected in any Frontline software data views, the corresponding audio data associated with those frames is also selected in the Wave Panel, Event Timeline and Event Table and vice-versa.

Protocol analysis tools synchronized to the Audio Expert System™ include:

- **Frame Display**
- **Coexistence View**
- **Bluetooth Timeline**
- **Message Sequence Chart**
- **Packet Error Rate Statistics**

When a portion of the waveform is selected in the Wave Panel, all frames within the selection will be highlighted in the **Frame Display**, **Coexistence View**, and **Bluetooth Timeline**.



Note: If the **Frame Display** is filtered to show non-audio events then the frames associated with selected audio events may not show.

8. Non-Referenced Mode

In Non-Referenced Mode, the system is typically processing audio of completely unknown program content (e.g. arbitrary music or speech content). Since the system does not have any prior knowledge of the audio being analyzed, the types of audio analysis that can be performed is limited.

The following events are reported whenever the system is operating in Non-Reference mode. These are the meaningful audio analysis that the system can perform without reporting too many false positive results.

- **Volume Level (Low Volume or High Volume):** Reported if the average volume level is not in a range conducive to performing meaningful audio analysis.
- **Clipping:** Amplitude distortion due to a signal amplitude exceeding the maximum value that can be represented by the digital system
- **Dropout:** Abrupt and very short duration intervals of silence
- **Glitch:** Extremely large sample-to-sample audio amplitude transitions that have little probability of occurring within natural speech or music

9. Referenced Mode

In Referenced Mode, the system operates in a “pseudo closed loop” test scenario where the user plays a specific Reference Audio file on the Source DUT. The Source DUT negotiates with the Sink DUT to determine the appropriate codec and audio parameters to use and will then process the Reference Audio file accordingly before transmitting the resulting audio via *Bluetooth*. The Reference Audio is a pre-recorded audio test file provided by Frontline in the ComProbe Protocol Analysis System installer.

The Sink DUT receives the encoded audio, decodes it, and processes it for playback. In parallel, the ComProbe BPA 600 analyzer snoops the over-the-air signal between the Source DUT and Sink DUT and emulates the RF reception and decoding done inside the Sink DUT. The Audio Expert System™ automatically detects that a Reference Audio file is being received and then analyzes the resulting audio for deviations from expected parameters.

Referenced Audio files are protocol specific.

The following events are reported whenever the system is operating in the Referenced mode.

- Test ID Found
- Test Script Not Found
- Invalid Test Script
- Synchronization Lost
- Unexpected Frequency
- Unexpected Level
- Unexpected Duration
- Amplitude Fluctuation
- Unexpected Phase Change
- Clipping
- Excess Noise
- CVSD HF Level Too High
- End of Test

Reference Audio Test Files

The Reference Audio files are specific audio files that exercise the system so that audio impairments can more efficiently and accurately be identified and reported. The Reference Audio files are composed of a series of back-to-back and relatively short duration tones of changing amplitude, frequency, and duration.

The test files are stored on the users computer In the directory "`\Frontline <version #>\Development Tools\Audio Expert Test Files\`". For example,

Test_1.03_48kHz_16Bit_3Loops_2Ch.wav



Note: Reference test files are periodically updated. Shown here is an example. Files delivered with your latest Frontline software version may have changed. Contact Frontline Technical Support for information on the latest reference file versions.

The test files have a set of tones forming a unique Test ID that lets the ComProbe analyzer know that it is capturing a test file instead of an arbitrary audio stream. There is no need for special configuration of the ComProbe analyzer. The Test ID will have the identifier notation N.vv, where N = the file number and vv = a two digit version, for example 1.02.

10. Referenced Mode Testing Processes

In the Referenced mode, the devices under test use a specific audio file (called reference file or test file) provided by Frontline whose contents are already known to the Frontline software. The software compares the parameters of the received audio data against its parameters and presents analysis for the user. Commonly, in Bluetooth technology the music sent via A2DP and speech sent via HFP. There are a few ways users can conduct referenced mode testing depending upon what profile they are using. The figure 17 shows the source of the audio and the medium through which it can be accessed by Source device to send to sink device via Bluetooth.

Table 5 - Referenced Mode Testing Process Between Two DUTs

Audio Source	Process to Send Using A2DP	Process to Send Using HFP
A file stored on the device's local memory	Play the locally stored file on the audio source device	Play using the third party App that transmits music data on HFP.
Streaming audio over a cellular network	Play the test in a browser on the audio source device https://youtu.be/rmirDbikrtM	Make a call to 434-964-1407 or 434-964-1304 through a cellular network. The phone number receiving the call playbacks recorded test signal.
Streaming audio over a Wi-Fi network	Play the test in a browser on the audio source device https://youtu.be/rmirDbikrtM	Make a call to 434-964-1407 or 434-964-1304 through a VoIP provider such as Skype. The phone number receiving the call playbacks recorded test signal. Potential problem: The VoIP provider might use custom codecs and cause undesirable behavior.

A2DP

Playing the test file locally

The simplest way to perform music data testing is to directly play the reference file from DUT1 to DUT2. To do that, save the reference file provided with the Frontline software on the Source device. Then connect the Bluetooth enabled devices and play the music file from one device to the other. The software will automatically detect the mode and present analysis for the user.

Playing the test file via Internet

If the user is testing a scenario where they need to analyze audio played through the internet (either using Wi-Fi or cellular data plan), they may access the reference file on YouTube provided by Frontline - <https://youtu.be/rmirDbikrtM>. Note that the software is only analyzing the Bluetooth link between the two DUTs. Any abnormalities at the Wi-Fi and cellular network level will affect the audio quality that may not be Bluetooth protocol related and the software will not be able to detect that.

HFP

Playing the test file by calling a phone number

Frontline provides the following phone numbers - 434-964-1407 and 434-964-1304 that users can call, to conduct speech audio data analysis over Bluetooth. The calls can be made using the cellular network (most common method) or VoIP. Again, the VoIP provider might use custom codecs and cause undesirable behavior which cannot be detected by Audio Expert System™ software.

Playing the test file using Third party Apps

Bluetooth Audio Expert System™ Reference mode testing can be accomplished using third party apps on Android, iOS, and Windows phones. The following apps are available from their respective App stores:

- [BTmono, Android](#)
- [Blue2Car, IOS](#)
- [Windows Headset player lite](#)



Note: When selecting and using these apps, thoroughly review all the vendor documentation. While Frontline has conducted testing of these apps, Frontline has not completed full interoperability testing with our library of *Bluetooth* devices and does not warrant the use of these apps with every device when using the following procedures. Frontline does not provide support or maintenance for third party apps. Any issues or questions should be directed to the app developer.


1. In the following steps Device Under Test 1 (DUT1) is the device sending the reference test file to DUT2.
2. Download the third party app to DUT1 and follow the app vendor's instructions for installation and use.
3. Load the Audio Expert System reference test file

"Test_1.02_64.1kHz_16Bit.wav"

on DUT1. The test file is stored on the users computer In the directory "\\Frontline <version #>\Development Tools\Audio Expert Test Files\".



Note: Reference test files are periodically updated. Shown here is an example. Files delivered with your latest Frontline software version may have changed. Contact Frontline Technical Support for information on the latest reference file versions.

4. With the BPA 600 or Soderia connected to the computer, configure the datasource, and follow procedures to capture data.
5. Launch Audio Expert System by clicking on the **Control** window .
6. Turn on Bluetooth on your DUTs, DUT1 and DUT2. Turn on the third party *Bluetooth* app for routing the reference file over A2DP or HFP by following the vendor's directions.
7. Send the reference test file from DUT1 to DUT2 via the third party app.
8. Observe the events in the Audio Expert System™ **Events Table**. Look for an event **Description**:

"TestIDFound : REF: Test ID 1.02, Channel Gain = -11.8 dB TermFreq=400.0".



Note: This is an example. The display may vary with the reference file version.

The Frontline analyzer has successfully detected the reference test signal and the system is locked into reference mode.

This quick start guide provides sufficient information to begin the data capture . Detailed hardware and software information is contained in the Audio Expert System Reference & User Guide. The manual is available on FTE.com.

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