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Bluetooth I/O

Introduction

The APx Bluetooth Duo option (page 9) is a hardware module available for the APx modular analyzers (the APx555, and the APx525 and 585 families of analyzers, including the APx582). It provides Bluetooth wireless technology source and sink interfaces.

The APx Bluetooth profiles support audio in a lower-quality (voice) mode (the HFP and HSP profiles) and in a higher-quality (music) mode (the A2DP profile).

See more About Bluetooth on page 140 and Using Bluetooth in a Sequence on page 555. See More About Supported Bluetooth Profiles on page 141.

This chapter discusses operation of the Bluetooth Duo option.APx500 version 4.5 supports the Bluetooth Duo option, and also provides support for the legacy Bluetooth modules. Operation of the legacy Bluetooth modules is discussed in Chapter 18.

Identification

The most obvious difference between the legacy Bluetooth modules and the Bluetooth Duo module is the number of external antennas: the legacy modules have one; Bluetooth Duo has two.

The Bluetooth Duo module carries the model number 229, and is identified in the Help > About product components list as Bluetooth Duo Module.

See more About Bluetooth on page 140, and Using Bluetooth in a Sequence on page 555. See More About Supported Bluetooth Profiles on page 141.

The Bluetooth Monitor

The status of a number of current Bluetooth settings is shown in the Bluetooth Monitor. Additionally, Bluetooth actions, settings and utility functions are available through a context menu (right-click in the Bluetooth Monitor display.) See Bluetooth Monitor on page 36.

Bluetooth Discovery, Pairing and Connection

Bluetooth connections require successful radio frequency (RF) communication between the APx analyzer and the DUT, and successful device handshaking through device discoverability, pairing and connection protocols. Data transfer is encrypted and must be authorized by the exchange of link keys, and personal identification number (PIN) codes may be required.

Bluetooth Settings are Global

Bluetooth settings are unique in APx500, in that they are *global*. This means the settings made in the Bluetooth Settings dialog affect the entire project: all measurements, all signal paths.

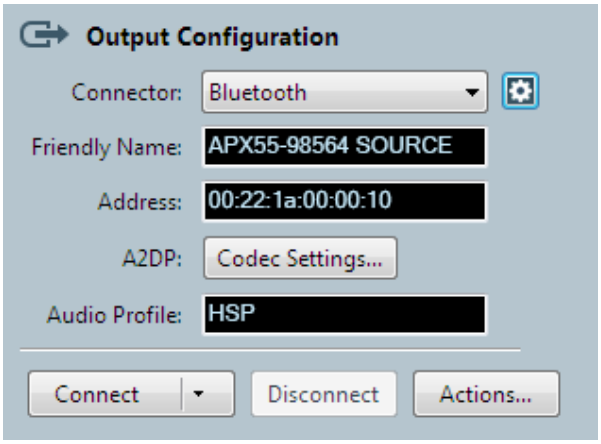
Source, Sink, Output and Input

When the APx **Output Configuration** is set to **Bluetooth**, the instrument can transmit audio using the A2DP Source profile, the HFP Audio Gateway profile, or the HSP Audio Gateway profile. When the APx **Input Configuration** is set to **Bluetooth** input, the instrument can receive audio using the A2DP Sink profile, the HFP Hands Free profile, or the HSP Headset profile.

There is one case where you are allowed to output audio and input audio simultaneously: Set the APx Profile to A2DP Sink, HFP Hand Free AVRCP Controller. Connect to the DUT using the HFP Profile. Since HFP is a bi-directional link, you can both send and receive audio.

Output Configuration: Bluetooth

This Signal Path Setup I/O selection enables output of audio from the APx generator to a Bluetooth device under test, using Bluetooth radio frequency (RF) transmission.



Note: The Bluetooth choice is only available for analyzers fitted with the APx Bluetooth Option module.

Connector

Choose **Bluetooth** here. Since the Bluetooth connection isn't valid until you choose, pair and connect with a device, the Bluetooth Settings dialog opens immediately. See page 132.

Settings

Click the **Settings...** button to discover, select, pair, connect and otherwise configure a Bluetooth link. See page 132.

Friendly Name

The friendly name of the APx Bluetooth module's source chip will appear here.

Address

The address of the APx Bluetooth module's source chip will appear here.

A2DP

The codec settings for the A2DP profile can be viewed and edited here.

Audio Profile

This displays the active profile, if any. See More About Supported Bluetooth Profiles on page 141.

Connect

If the APx is already paired with one or more Bluetooth devices, you can open the **Connect** flyout menu to select a device and one or more profiles for connection. See More About Supported Bluetooth Profiles on page 141.

Disconnect

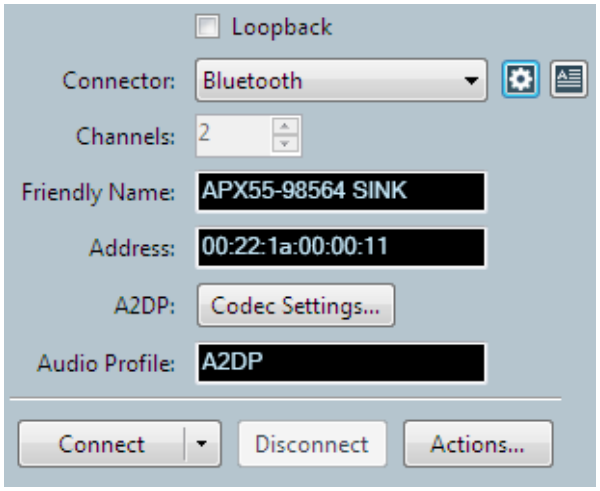
If the APx is already connected to a Bluetooth device, you can click the **Disconnect** button to terminate the connection.

Actions

Click **Actions** to open the **Bluetooth Actions** dialog. If the APx is already connected to a Bluetooth device, you can initiate Bluetooth Actions from this dialog. Only the actions appropriate to the current connection and profile are shown. See Actions on page 139.

Input Configuration: Bluetooth

This selection enables input of audio from a Bluetooth device under test, using Bluetooth radio frequency (RF) transmission.



Note: The Bluetooth choice is only available for analyzers fitted with the APx Bluetooth Option module.

Loopback

Loopback is not available when either the Output or Input Configuration is set to Bluetooth.

Connector

Choose **Bluetooth** here. Since the Bluetooth connection isn't valid until you choose, pair and connect with a device, the Bluetooth Settings dialog opens immediately. See page 132.

Settings

Click the **Settings...** button to discover, select, pair, connect and otherwise configure a link with a Bluetooth device. See page 132.

Edit Channel Labels

In the Channel Labels dialog you can rename the input channels with names of your choice. See page 56. These settings are project-wide, but can be overridden for any measurement result. To set project colors, click the **Project Colors...** button in the Labels dialog, or go to the Project/Sequence Properties dialog, Colors tab. See Setting Graph Colors and Styles on page 30.

Channels

This is a reading field that displays the current input channel count, determined by profile settings.

Friendly Name

The friendly name of the APx Bluetooth module's sink chip will appear here.

Address

The address of the APx Bluetooth module's sink chip will appear here.

A2DP

The codec settings for the A2DP profile can be viewed and edited here.

Audio Profile

This displays the active profile, if any. See More About Supported Bluetooth Profiles on page 141.

Connect

If the APx is already paired with one or more Bluetooth devices, you can open the **Connect** flyout menu to select a device and one or more profiles for connection. See More About Supported Bluetooth Profiles on page 141.

Disconnect

If the APx is already connected to a Bluetooth device, you can click the **Disconnect** button to terminate the connection.

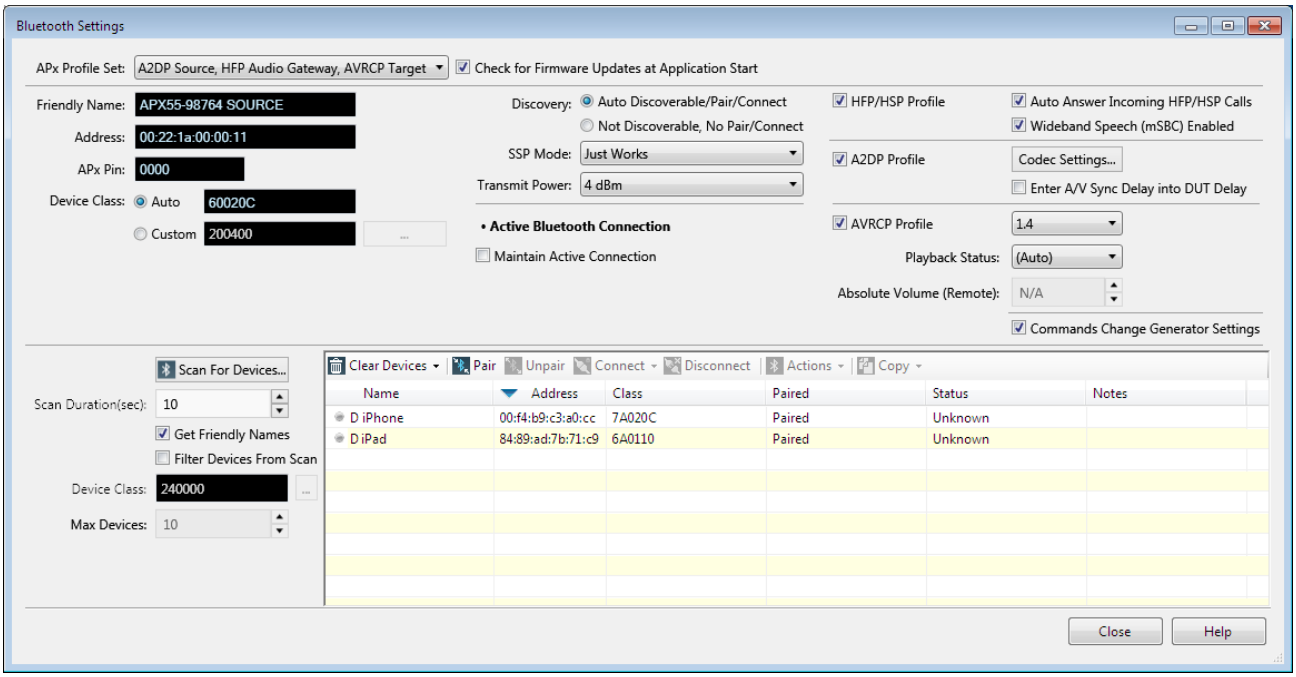
Actions

Click **Actions** to open the **Bluetooth Actions** dialog. If the APx is already connected to a Bluetooth device, you can initiate Bluetooth Actions from this dialog. Only the actions appropriate to the current connection and profile are shown. See Actions on page 139.

Operation with absent or corrupt interface signal

When Input Configuration is set to a digital input and no signal is present, or if the signal is corrupt or out of range, the input receiver cannot lock (synchronize) to the interface signal, and no valid audio can be recovered. The sample rate indicator in the Status Bar will display an "unlocked" warning, and any measurement result referencing audio from the unlocked input will display an "----" (invalid) result. See page 632 for more about invalid results.

Bluetooth settings dialog for Bluetooth Duo



Bluetooth Settings dialog for Bluetooth Duo, shown in the A2DP Source, HFP Audio Gateway, AVRCP Target profile set.

This topic explores Bluetooth Duo settings dialog. The legacy Bluetooth settings dialog is discussed beginning on page 148.

This dialog provides settings for Bluetooth discovery, pairing, connection and other configuration. Unlike most APx settings, Bluetooth profile selection, pairing and connection settings are global to the APx project. Settings made here affect both Bluetooth source and sink configurations across all signal paths in the project.

A flow chart depicting discovery, pairing and connection paths is shown on page 139.

APx Profile Set

APx has four sets of profiles that the Bluetooth Option module can assume. Each set lists the profiles available for connection and/or the profiles available for access by a remote device. Choose an APx Bluetooth Profile Set here.

- A2DP Source, HFP Audio Gateway, AVRCP Target
- A2DP Source, HSP Audio Gateway, AVRCP Target
- A2DP Sink, HFP Hands Free, AVRCP Controller
- A2DP Sink, HSP Headset, AVRCP Controller

In A2DP Source, the APx Bluetooth transmitter mutes the audio when the average signal level falls below –54 dBFS for more than 1 second. We recommend maintaining test levels above –54 dBFS for meaningful results.

Check for Firmware Updates at Application Start

The Bluetooth Duo hardware module can update its firmware in the field, using update files that are included with the APx500 software distribution. See Update Bluetooth Firmware on page 135.

APx Identification

The upper left side of the dialog displays a number of APx Identification settings readable by other Bluetooth devices.

Friendly Name

The friendly name of the APx Bluetooth module's Source or Sink chip is displayed here.

Address

The Address of the APx Bluetooth Source or Sink chip is displayed here.

APx PIN

The APx Bluetooth PIN is displayed here.

Device Class

- **Auto**
  Auto uses the Device Class assigned by default: for the Source chip, 60020C; for the Sink chip, 240408.
- **Custom**
  Custom allows you to select a Device Class for the active APx Bluetooth chip. Use the ... browse button to open the Edit Device Class Dialog (page 137).

Discovery

Auto Discoverable/Pair/Connect

When this is selected (the default), the APx Bluetooth Option is discoverable by remote Bluetooth devices. If the remote device initiates pairing, the APx will pair. If the remote device initiates connection, the APx is available to connect for the profiles checked here.

Not Discoverable, No Pair/Connect

When this is selected, the APx Bluetooth Option is not discoverable by remote devices, and it will not respond to pairing or connection initiated by remote device.

SSP Mode

APx provides four SSP (Secure Simple Pairing) options. The **Just Works** choice is used in Bluetooth device relationships that require little security. The **Numeric Comparison** choices are man-in-the-middle (MITM) interactions for device relationships that require higher security. Choose the SSP Mode that is appropriate for the Bluetooth device you are testing. See More About Secure Simple Pairing on page 142 for detailed information.

- Just Works
- Numeric Comparison, Display Only
- Numeric Comparison, Display+Buttons
- Numeric Comparison, Keyboard

Transmit Power

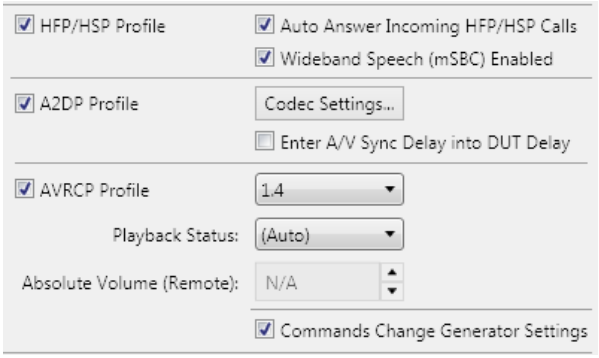
You can choose one of eight RF output transmission power levels between –20 dBm and +8 dBm. The default is +4 dBm.

Active Bluetooth Connection

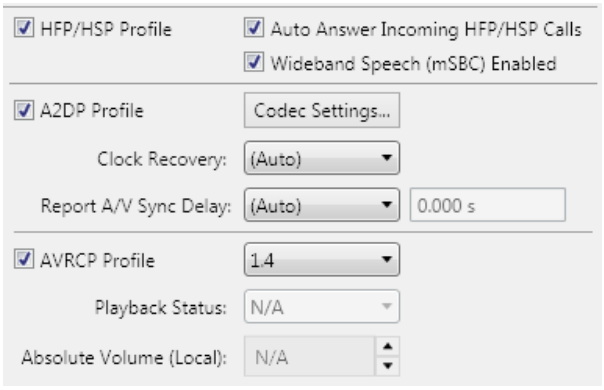
☑ If **Maintain Active Connection** is checked, the APx Bluetooth Option will remain connected to the Bluetooth device under test throughout the project, even across Signal Paths. However, if you change to Bench Mode, the Bluetooth device will be disconnected.

Profile Configurations

The upper right side of the dialog displays a number of APx profile configurations. The controls and settings here vary with Source or Sink (Target or Controller) settings.



Profile Configurations for Source/Target settings



Profile Configurations for Sink/Controller settings

HFP/HSP Profile

☑ If this box is checked, the HFP/HSP profile is enabled. You may elect to use the profile at connection time, or not. If this box is unchecked, the HFP/HSP profile will not be available on the connection menu. These further options are available:

- ☑ Auto Answer Incoming HFP/HSP Calls
- ☑ Wideband Speech (mSBC) Enabled

A2DP Profile (when APx Profile is set to Source)

☑ If this box is checked, the A2DP profile is enabled for Source. You may elect to use the profile at connection time, or not. If this box is unchecked, the A2DP profile will not be available on the connection menu. These further options are available:

Codec Settings...

This button opens the A2DP Codec Settings dialog. See page 135.

A/V Sync Delay

☐ Enter A/V Sync Delay into DUT Delay. See page 136.

A2DP Profile (when APx Profile is set to Sink)

If this box is checked, the A2DP profile is enabled for Sink. You may elect to use the profile at connection time, or not. If this box is unchecked, the A2DP profile

will not be available on the connection menu. These further options are available:

Codec Settings...

This button opens the A2DP Codec Settings dialog. See page 135.

Clock Recovery

Clock Recovery enables or disables the sink clock recovery algorithm. See page 136.

- **Fixed**
  Fixed (the default) sets the A2DP sink sample rate to the negotiated rate.
- **(Auto)**
  Auto enables the A2DP sink clock recovery algorithm.

Report A/V Sync Delay

Report A/V Sync Delay to the connected Source device. See page 136.

- **(Auto)** (the default)
  Auto reports the APx Bluetooth Sink chip A/V Sync Delay.
- **Custom**
  Custom allows you to enter an arbitrary A/V Sync Delay value to be reported.

☑ AVRCP Profile (when APx Profile is set to Target)

If this box is checked, the AVRCP profile is enabled for Target. You may elect to use the profile at connection time, or not. If this box is unchecked, the AVRCP profile will not be available on the connection menu. The latest AVRCP supported by APx is version 1.4. As an alternative, you may choose AVRCP version 1.0 here.

These further options are available:

Playback Status

See page 137.

Absolute Volume (Remote)

See page 137.

☑ Commands Change Generator Settings. See page 138.

☑ AVRCP Profile (when APx Profile is set to Controller)

If this box is checked, the AVRCP profile is enabled for Controller. You may elect to use the profile at connection time, or not. If this box is unchecked, the AVRCP profile will not be available on the connection menu. The latest AVRCP supported by APx is version 1.4. As an alternative, you may choose AVRCP version 1.0 here.

These further options are available:

Playback Status

See page 137.

Absolute Volume (Local)

See page 137.

Scan

The lower left area of the dialog has controls and settings to scan for nearby Bluetooth devices.

Scan for Devices

This button initiates a scan to identify all the discoverable Bluetooth devices within range. Discovered devices are listed in the Current Devices List.

Scan Duration

This setting limits the scan time to the value set. The maximum time is 48 seconds. The default is 10 seconds.

☑ Get Friendly Names

By default, APx asks for a device's friendly name. In automated processes, this process adds extra time. Uncheck this checkbox to disable this feature.

☑ Filter Devices From Scan

You can filter the scan so only a certain Bluetooth Device Class will be shown. Click the browse button to open the Edit Device Class dialog.

Device Class

You can select a Device Class as a filter for the scan. Use the ... browse button to open the Edit Device Class Dialog (page 137).

Max Devices

You can limit the number of devices found in the filtered scan here. The default is 10 devices.

Current Devices List

The Current Devices List occupies most of the lower part of the dialog.

This grid shows the devices discovered in the scan, along with information fields. There are controls to pair, unpair, connect, disconnect, initiate actions and to copy the device Bluetooth address and link key. Select a device to configure the relationship.

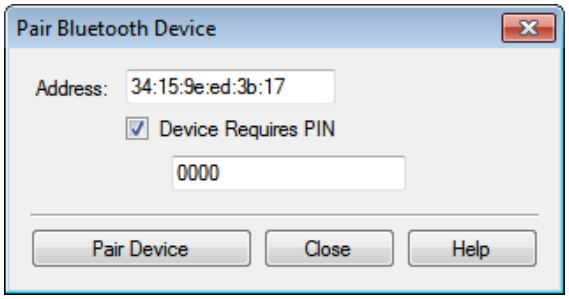
Clear Devices

You can choose to remove all devices from the list, or all paired devices, or all unpaired devices. When a device is removed from the list, any pairing information for that device is also removed. Click **Scan** to repopulate the list.

Pair

Pairing provides a way for devices to exchange link keys. To pair with a device, refer to the documentation received with the device. To enable pairing, you will typically be required to execute a command or series of commands at the device. When pairing is enabled,

select the device in the Current Devices List, and click **Pair**. A Pair Bluetooth Device dialog box will open.



Some devices may require the exchange of a PIN code. The APx Bluetooth PIN code is set to 0000; a field in the pairing dialog allows input of a remote device's PIN code.

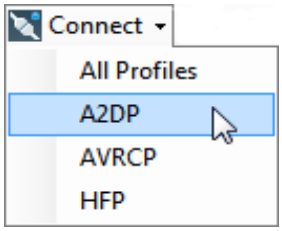
Pairing information is saved in the project, until the Current Devices List is cleared, or the until device is Unpaired.

Unpair

Unpairs the selected, previously paired device.

Connect

Connects to the selected, previously paired device. A Connect menu opens. Select the profile you would like to offer to the device.



Disconnect

Disconnects the selected, connected device.

Actions

Opens various **Actions** dialogs. This duplicates the function of the Actions button shown on Signal Path Setup, without the necessity of leaving the Bluetooth Settings dialog. See page 139.

Copy

Copies the device address and key link to the Windows Clipboard. This text can then be pasted into another application or tool.

Update Bluetooth Firmware

The Bluetooth Duo hardware module can update its firmware in the field, using update files that are included with the APx500 software distribution.

If **Check for Firmware Updates at Application Start** (located at the top of the Bluetooth Settings panel) is ☑ checked, each time the APx500 application is launched it will check to verify that the Bluetooth firmware is correct for the APx500 version. If the firmware requires updating, the update will begin immediately and a progress dialog will be displayed. The update may take a few minutes.

If **Check for Firmware Updates at Application Start** is ☐ unchecked, the APx500 application will not check for updates at launch. Instead, it will check for updates if and when Bluetooth is selected as an Input or Output. At that time, the update may take a few minutes.

If the Bluetooth firmware is the correct version for the APx500 software, you will not be prompted to update.

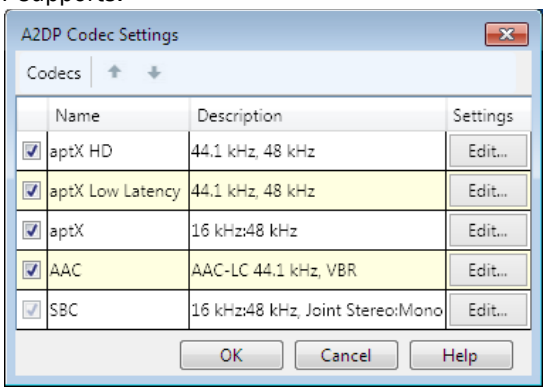
Codec Settings

A2DP Codec Settings

The Bluetooth A2DP profile always supports the SBC audio codec. Additional codecs are optional.

In APx, you can select which optional codecs you would like to support, and edit features of the codecs you choose.

Using the arrow icons at the top of the dialog, you can set an order of priority. APx will move from the top-most codec downward until finding the codec that the DUT supports.



Codecs supported, in default order of priority:

aptX HD

You can choose to support either or both of the following sample rates for the aptX HD codec:

- 48 kHz
- 44.1 kHz

aptX Low Latency

You can choose to support either or both of the following sample rates for the aptX Low Latency codec:

- 48 kHz
- 44.1 kHz

aptX

You can choose to support any or all of the following sample rates for the aptX codec:

APx as A2DP source:

- 48 kHz
- 44.1 kHz
- 32 kHz
- 16 kHz

APx as A2DP sink:

- 48 kHz
- 44.1 kHz
- 32 kHz
- 16 kHz

AAC

The AAC codec is fixed at MPEG-2/4, AAC-LC, 44.1 kHz, 2 channels.

By default, variable bit rate (VBR) is set. You can deselect variable bit rate to enforce fixed bit rate.

SBC

You can choose to support any or all of the following sample rates for the SBC codec:

APx as A2DP source:

- 48 kHz
- 44.1 kHz
- 32 kHz
- 16 kHz

APx as A2DP sink:

- 48 kHz
- 44.1 kHz
- 32 kHz
- 16 kHz

Additionally, you can choose to support any or all of the following channel modes:

- Joint Stereo
- Stereo
- Dual Channel
- Mono

Clock Recovery

Bluetooth A2DP Sink Clock Recovery

Clock Recovery: Fixed (the default) does not attempt to algorithmically correct transmission errors, but sets the A2DP sink sample rate at the negotiated rate. This provides stable frequency measurements, but may occasionally be subject to glitches due to packet loss or buffer overruns. Generally, we recommend using the **Fixed** setting, particularly when using the aptX Low Latency codec.

Clock Recovery: (Auto) engages an A2DP sink algorithm that compensates for RF packet loss or sample rate drift between source and sink. Ideally, this compensation is unnoticed by the listener, providing a pleasant listening experience; it will, however, create small but measurable sample rate and audio frequency variations.

A/V Sync Delay

A/V Sync Delay

AV Sync Delay features are not supported by the Legacy Bluetooth Option.

This feature of A2DP allows the sink device to notify the source device of any rendering delay, enabling the source device to compensate for the delay.

For example, a source device may provide video to a television monitor via a hard-wired connection, but route the audio through a Bluetooth A2DP connection to speakers or headphones. Any delay in the audio path will cause the audio to lag the video. If the source device is informed of the rendering delay in the sink device, it can delay the video stream by that amount and maintain proper synchronization between video and audio.

A2DP Source

When A2DP Source is selected, you can choose **Enter A/V Sync Delay into DUT Delay** to apply the delay reported by the remote sink device to the APx DUT Delay feature.

The delay value entered into DUT Delay is updated each time the remote device reports a new delay value.

The Bluetooth Monitor will indicate the delay reported from the remote sink device. If the remote device does not support this feature, the monitor entry will read "N/A".

A2DP Sink

When A2DP Sink is selected, APx provides an A/V Sync Delay value for the remote device to read.

For **Report A/V Sync Delay** you can choose either

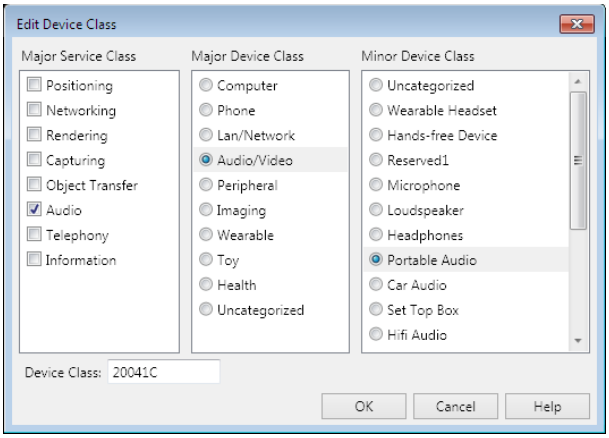
- (**Auto**)
  Auto reports the current delay in the Bluetooth chip internal to the APx, which will vary with configuration and connection.

or

- **Custom**
  Custom allows you to enter an arbitrary delay value for the remote source device to read. The range is 100 ns to 1.6 s.

Edit Device Class

This dialog will generate a Bluetooth Device Class hex code from your selections.



Choose one or more Major Service Class(es), a Major Device Class, and a Minor Device Class (if available.) This dialog will also identify a Device Class if you type a valid hex code in the Device Class field, and press the Enter key on the PC keyboard.

APx Device Class

If you have come to this dialog from the APx Custom Device Class setting, click OK to enter the code generated here as the APx Custom Device Class, which will be asserted in both Source and Sink profiles.

Scan Filter Device Class

If you have come to this dialog from the Filter Devices From Scan setting, click OK to enter the code generated here as the scan filter Device Class.

> *Note: this feature is not supported by the Legacy Bluetooth Option.*

AVRCP Playback Status

> *AVRCP Playback Status features are not supported by the Legacy Bluetooth Option.*

Playback Status is a feature introduced in AVRCP 1.3. This feature is intended to allow devices such as car kits to ask a phone whether a song is playing or not. This prevents certain “out of band” audio noises from the user, such as key presses while dialing a phone number. The car kit will suppress audio from the A2DP source device (which is also the AVRCP target) when the play status is not PLAYING.

AVRCP Controller profile

In the AVRCP Controller profile, APx acts as a A2DP rendering device (a sink such as a speaker or headphone), receiving an audio stream from a remote media player such as a phone. APx uses AVRCP Commands to control the remote media player.

When the AVRCP Controller profile is selected, the Playback Status Event checkbox on the Bluetooth Settings panel allows you to enable or disable Playback Status.

This setting is enabled by default. Toggling this setting will disconnect any active connection.

When the AVRCP Controller profile is selected, and Playback Status Event is enabled, and the connected AVRCP Target device supports this notification, the Play Status is indicated in the Bluetooth Monitor. If the connected AVRCP Target device does not support it, the Bluetooth Monitor should indicate “N/A”.

AVRCP Target profile

In the AVRCP Target profile, APx acts as an A2DP source device, sending an audio stream to a remote rendering device (speaker or headphones). APx responds to AVRCP Commands sent from the remote rendering device.

When the AVRCP Target profile is selected, the Playback Status Event checkbox on the Bluetooth Settings panel allows you to enable or disable Playback Status. This setting is enabled by default. Toggling this setting will disconnect any active connection.

When the AVRCP Target profile is selected, and Playback Status Event is enabled, you can navigate to **Actions > A2DP Sink/AVRCP > Playback Status** to open a dialog to set a response to the remote AVRCP Controller (sink) device. The Playback Status control provides a menu that has the following options: Auto, Stopped, Playing, Paused, Fwd Seek, Rev Seek, Error. The default selection is Auto.

For any choice except Auto, the selected Playback Status will be passed to the AVRCP Controller device.

If Auto is selected, APx will set the status to Playing when the generator is turned on. When A2DP streaming is started, the playback status will be Paused when the generator is off. When A2DP streaming is stopped, the playback status will be Stopped when the generator is off.

The Playback status value is only updated when the active audio stream is A2DP. Playback status changes should not be made when the audio path is SCO.

Absolute Volume

> *AVRCP Absolute Volume control features are not supported by the Legacy Bluetooth Option.*

AVRCP Absolute Volume Control is a feature introduced in AVRCP 1.3. This feature is intended to allow the source device to specify a percentage value of full

volume to the rendering device (speaker or headphones). The rendering device responds with a notification of the current absolute volume level.

APx supports features of Absolute Volume Control in both the AVCRP Controller (A2DP sink) and Target (A2DP source) profiles.

AVCRP Controller profile

In the AVRCP Controller profile, APx acts as a A2DP rendering device (a sink such as a speaker or headphone), receiving an audio stream from a remote media player. APx uses AVRCP Commands to control the remote media player.

When the AVRCP Controller profile is selected, the Absolute Volume checkbox on the Bluetooth Settings panel allows you to enable or disable Absolute Volume. This setting is enabled by default. Toggling this setting will disconnect any active connection.

When Absolute Volume is enabled in the AVRCP Controller profile and the remote Target (source) device supports Absolute Volume, you can navigate to Actions > A2DP Sink/AVRCP > Absolute Volume to open a dialog to set an Absolute Volume level value, which can

be read by the remote AVRCP Target device. Values are integers from 0-127. If the Target device does not support Absolute Volume, this control is unavailable.

...in a sequence

When the AVRCP Controller profile is selected, a sequence step is available to set the Absolute Volume level on the A2DP sink device. When the step is included in a sequence and loaded on an APx analyzer that does not support Absolute Volume, an error occurs when the step is executed. When the step is included in a sequence and loaded on an analyzer that supports Absolute Volume, but connected to a remote device that does not support it, an error occurs when the step is executed.

In a sequence when the AVRCP Controller profile is selected, and the remote AVRCP Target device supports Absolute Volume, the Absolute Volume level set in the local A2DP sink device (the APx analyzer) is displayed on the report for each measurement in the sequence.

AVRCP Target profile

In the AVRCP Target profile, APx acts as an A2DP source device, sending an audio stream to a remote rendering device (speaker or headphones). APx responds to AVRCP Commands sent from the remote rendering device.

When the AVRCP Target profile is selected, the Absolute Volume checkbox on the Bluetooth Settings panel allows you to enable or disable Absolute Volume. This setting is enabled by default. Toggling this setting will disconnect any active connection.

When Absolute Volume is enabled in the AVRCP Target profile and the remote AVRCP Controller (sink) device supports Absolute Volume, you can navigate to Actions > A2DP Sink/AVRCP > Absolute Volume to open a dialog to send an Absolute Volume command to the remote AVRCP Controller device. Values are integers from 0-127. If the remote AVRCP Controller device does not support Absolute Volume, this control is unavailable.

When the AVRCP Target profile is selected, and the remote AVRCP Controller device reports its Absolute Volume level, the level is read and displayed in the APx Bluetooth Monitor. If the remote device does not support Absolute Volume control, the Bluetooth Monitor indicates “N/A” for this value.

When the AVRCP Target profile is selected, a nested sweep parameter called “Absolute Volume” is available. This parameter allows the AVRCP Controller (A2DP sink) device manufacturer to test audio output at various levels, plotted on one graph.

...in a sequence

When the AVRCP Target profile is selected, a sequence step is available to set the Absolute Volume level on the remote device. When the step is included in a sequence, and loaded on an APx analyzer which does not support Absolute Volume, an error occurs when the step is executed. When the step is included in a sequence, and loaded on an analyzer that does support Absolute Volume, but the remote device does not support it, an error occurs when the step is executed.

In a sequence when the AVRCP Target profile is selected and the remote AVRCP Controller device supports Absolute Volume, the Absolute Volume level reported by the remote device is read by APx and displayed on the report for each measurement in the sequence.

Commands Change Generator Settings

When APx is configured for A2DP Source AVRCP Target, the APx generator can now respond to certain AVRCP commands.

AVCRP Target profile

In the AVRCP Target profile, APx acts as an A2DP source device, sending an audio stream to a remote rendering device (speaker or headphones). APx responds to AVRCP Commands sent from the remote rendering device.

When the AVRCP Target profile is selected, the **Commands Change Generator Settings** ☑ checkbox on the Bluetooth Settings panel allows you to enable or disable this feature. This setting is enabled by default.

AVRCP generator commands are only acted upon when the active measurement has a generator with an ON/OFF button, and the generator is not disabled.

Commands

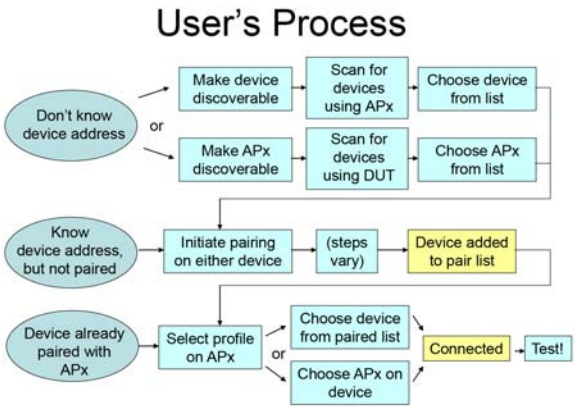
- The AVRCP command **Play** turns the generator **On**
- The AVRCP command **Pause** turns the Generator **Off**
- The AVRCP command **Stop** turns the Generator **Off**, and **stops** A2DP streaming.
- The AVRCP command **Next Track** increases the generator **Frequency** equivalent to pressing the **up** arrow on the frequency control in the panel
- The AVRCP command **Prev Track** decreases the generator **Frequency** equivalent to pressing the **down** arrow on the frequency control in the panel.
- The AVRCP command **Volume Up** increases the generator **Level** on **Ch1** equivalent to pressing the **up** arrow on the level control in the panel. **Volume Up** messages are **not** received in legacy Bluetooth modules.
- The AVRCP command **Volume Down** decreases the generator **Level** on **Ch1** equivalent to pressing the **down** arrow on the level control in the panel. **Volume Down** messages are **not** received in legacy Bluetooth modules.

Steps in connecting APx to a Bluetooth device

There are 3 steps involved in setting up a connection between any Bluetooth devices. APx500 software provides more visibility and control of options for these communication steps than most DUTs.

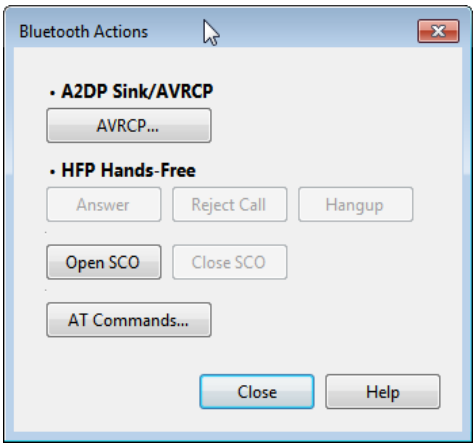
- **Discovery**
  Discovery scans the area and lists any Bluetooth devices that are not “undiscoverable” (hidden). Many devices are undiscoverable by default, and must be set to a discoverable mode through a switching sequence.
- **Pairing**
  Pairing establishes a mutual, secure relationship between devices that have at least one compatible profile. Pairing is stored in non-volatile memory in each device. Devices can pair with more than one other device.
- **Connection**
  Paired devices can connect using compatible profiles and roles. Connection enables exchange of audio or control data. Each device can connect with only one device at a time.

Process for discovery, pairing and connection



Actions Dialogs

Bluetooth Actions are commands that can be sent from the APx analyzer to the Bluetooth device. The current Bluetooth profile(s) and connection determine which commands are available in the Bluetooth Actions dialog box.



Typical Actions Dialog

Bluetooth Actions for A2DP Source, HFP AG, AVRCP Target

For this profile set, these actions are available:

A2DP Source

For A2DP Source, the actions are

- Start Streaming / Stop Streaming

HFP Audio Gateway

For HFP Audio Gateway, the actions are

- Open SCO
- Dial
- Ring
- Close SCO

- Hangup

A "SCO" is a "Synchronous connection-oriented" link, which is the type of radio link Bluetooth uses for voice data. The SCO link is used in the APx supported protocols HFP and HSP.

Bluetooth Actions for A2DP Source, HSP AG, AVRCP Target

For this profile set, these actions are available:

A2DP Source

For A2DP Source, the actions are

- Start Streaming / Stop Streaming

HSP Audio Gateway

For HSP Audio Gateway, the actions are

- Open SCO
- Close SCO
- Ring

Bluetooth Actions for A2DP Sink, HFP Hands Free, AVRCP Controller

For this profile set, these actions are available:

A2DP Sink/AVRCP

For A2DP Sink/AVRCP, click the

- AVRCP...

button to open the Send AVRCP Command transport controls panel:

PREVIOUS TRACK	REWIND	FAST FORWARD	NEXT TRACK	PLAY	PAUSE	STOP	VOLUME UP	VOLUME DOWN	MUTE

HFP Hands-Free

For HFP Hands Free, the actions are

- Answer
- Reject Call
- Hangup
- Open SCO
- Close SCO

AT Commands

For AT Commands, click the

- AT Commands...

button to open the Send AT Commands panel. See page 140.

Bluetooth Actions for A2DP Sink, HSP Headset, AVRCP Controller

For this profile set, these actions are available:

A2DP Sink

For A2DP Sink/AVRCP, click the

- AVRCP...

button to open the Send AVRCP Command transport controls panel:

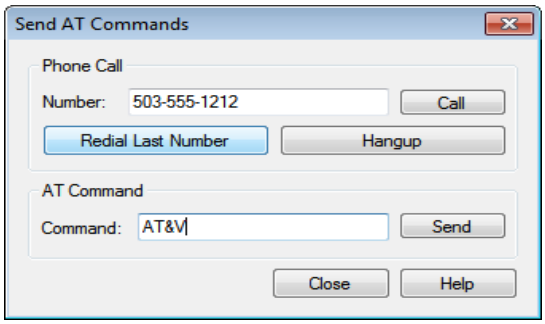
PREVIOUS TRACK	REWIND	FAST FORWARD	NEXT TRACK	PLAY	PAUSE	STOP	VOLUME UP	VOLUME DOWN	MUTE

HSP Headset

For HSP Headset, the actions are

- Button
- Open SCO
- Close SCO

Bluetooth: Send AT Commands Dialog



You can open the Send AT Commands dialog by clicking Actions > AT Commands from Signal Path Setup, or from the context menu opened by right-clicking in the Bluetooth Monitor.

You must have an APx input or output configured for Bluetooth, and be paired and connected to an appropriate Bluetooth HFP profile device.

Phone Call

To make a phone call, enter a new phone number in the Number field and click **Call**, or click **Redial Last Number**. Disconnect a phone call by clicking **Hangup**.

AT Command

Enter any valid AT command as a text string, and click **Send** to transmit the command to the connected device.

More About Bluetooth...

General

Bluetooth is a short-distance (a few meters) control, data, and audio communications wireless technology. Bluetooth replaces wires in the user's "personal area."

Bluetooth uses low power, frequency-hopping radio in the 2.4 GHz band. Communication is two-way (for handshaking, metadata, etc); some profiles (HFP, for

example) support duplex audio (both directions simultaneously); some profiles (A2DP) support only simplex audio (one direction per connection).

Typical uses are mouse, keyboard, cell phone, headphones, hands-free talk and listen.

APx Bluetooth Option

An APx Bluetooth Option module must be fitted in the analyzer instrument to enable Bluetooth transmission and reception. See Bluetooth Option on page 9.

Bluetooth Profiles

Bluetooth has about 30 “profiles” that describe the capabilities and/or current operating modes for Bluetooth devices. For devices to communicate, they must support and share a common profile.

For example, a wireless mouse uses the “HID” profile, which has no audio capabilities. Wireless headphones use the “A2DP” profile, which has no cursor control capabilities. The Bluetooth profiles these devices use are not compatible with each other.

APx supported profiles

The APx Bluetooth Option supports four Bluetooth profiles. The supported profiles are

- **A2DP** (Advanced Audio Distribution Profile)
  This is a one-way (source or sink), relatively high-quality stereo audio profile.
- **HFP** (Hands Free Profile)
  This is a bi-directional voice communications audio profile that includes AT-type commands for phone use. Legacy Bluetooth DUTs support only the CSVD codec at sample rate of 8 kHz; HFP 1.6 compatible DUTs support the wideband voice mSBC codec at a sample rate of 16 kHz.
- **HSP** (Head Set Profile)
  This is a simpler version of HFP, using the CSVD codec at 8 kHz and a reduced set of AT commands.
- **AVRCP** (Audio Video Remote Control Profile)
  This provides Play-Pause-Forward-Reverse “remote control” transport-type commands to control an audio source. This profile is typically used in conjunction with A2DP for personal audio player applications.

More about Supported Bluetooth Profiles

HSP

HSP is the “Head Set Profile.” This profile supports voice-quality audio, using the CVSD codec at 8 kHz sample rate. This profile is used for phone-to-headset communication.

Roles

Supported roles are AG “Audio Gateway” (the phone) and HS “Headset”.

Audio

Audio flows in a duplex (bi-directional) mode, connecting the Audio Gateway device to the Headset device.

Actions

A subset of AT commands are also supported for phone operations.

HFP

HFP is the “Hands Free Profile.” This profile supports voice-quality audio, using the CVSD codec at 8 kHz sample rate or the HFP 1.6 “wideband speech” mSBC codec at 16 kHz*. This profile is used for phone-to-headset communication and for phone-to-car kit hands free communication.

**Note: HFP 1.6 wideband speech is only available if the mSBC codec is supported by your Bluetooth module hardware. See Bluetooth Option on page 9 for more information.*

Roles

Supported roles are AG “Audio Gateway” (the phone) and HF “Hands Free” (the headset or car kit mic/speaker).

Audio

Audio flows in a duplex (bi-directional) mode, connecting the Audio Gateway device to the Hands Free device.

Actions

A subset of AT commands are also supported for phone operations. Compared to HSP, HFP provides a few more AT commands for hands-free convenience, such as last number redial.

A2DP

A2DP is the “Advanced Audio Distribution Profile.” This profile supports higher bit rate, higher performance stereo audio.

Roles

APx supported profile roles are “source” (transmitting audio) and “sink” (receiving audio). Audio is distributed in one direction only, from the source device to the sink device.

Audio

The SBC codec is mandatory; Audio Precision Bluetooth Options also support the aptX codec. The Bluetooth Duo option also supports aptX HD, aptX Low Latency and AAC codecs. In A2DP Source, the APx Bluetooth transmitter mutes the audio when the average signal level falls below –54 dBFS for more than 1

second. We recommend maintaining test levels above –54 dBFS for meaningful results.

AVRCP

AVRCP is the "Audio/Video Remote Control Profile." This profile is used in conjunction with A2DP, and provides "transport" controls such as Play, Pause, Reverse, Forward, etc.

Roles

Supported profile roles are "controller" and "target."

Note: when APx is the target, AVRCP commands are ignored.

More about Bluetooth SSP (Secure Simple Pairing) Mode

SSP is required for devices using Bluetooth v 2.1 and later. Bluetooth v 2.0 and earlier devices use Legacy Pairing.

APx provides four SSP (Secure Simple Pairing) options. You must choose the option that is appropriate for the Bluetooth device you are testing.

Man-in-the-middle (MITM)

Man-in-the-middle or MITM is the term used in Bluetooth technology to refer to Secure Simple Pairing mechanisms that require human interaction. One device may display a PIN, for example, and the user may be required to enter the same PIN using a keyboard on a second device. MITM methods add security to the pairing process.

APx SSP Modes

Just Works

This mode is used in Bluetooth device relationships that require little security, such as headsets. User interaction is not required.

Numeric Comparison, Display Only

Some Bluetooth devices have only a display screen to interact with a user; an example is a car kit (car stereo head unit). Use this mode when APx is playing the role of such a device.

A use case would be testing a smart phone. APx would be an A2DP Sink, HFP with a display only (the car kit), and the DUT would be the smart phone. The phone would initiate pairing, and APx would display the PIN transmitted from the phone. The user would confirm (using a button on the phone) that the PIN displayed in APx matched the PIN on the phone.

Numeric Comparison, Display+Buttons

Some Bluetooth devices have a display screen and one or more buttons to interact with a user; the button may be used for a binary (Yes/No) response to a query. An example is a smart phone. Use this mode when APx is playing the role of such a device.

A use case would be testing a car kit. APx would be an A2DP Source, HFP Hands-Free with a display and buttons (the smart phone), and the DUT would be the car kit. APx would initiate pairing and transmit a PIN to the DUT. The DUT would display the PIN, and the user would confirm (using a button in the APx prompt dialog) that the PIN in the DUT display and the APx PIN matched.

Numeric Comparison, Keyboard

Some Bluetooth devices have a numeric or alphanumeric keyboard to interact with the user. An example is a computer used as an audio source, distributing iTunes audio to a home entertainment system. Use this mode when APx is playing the role of such a device.

There are not obvious use cases in audio test for this mode, which is include in APx for completeness. A non-audio test use case would be pairing a Bluetooth keyboard to a tablet computer. The computer would display a PIN, and the user would enter a PIN (using the keyboard) that matches the PIN on the tablet screen.

Legacy Pairing

Bluetooth v2.1 and later devices (such as APx) are permitted to use Legacy Pairing modes when pairing with a Bluetooth v2.0 or earlier device.

Glossary of Bluetooth terms

These terms are used in the Audio Precision Bluetooth audio testing implementation.

A2DP
: is the Advanced Audio Distribution Profile, with two roles: source and sink. This profile supports higher bit rate, higher performance stereo audio, with sample rates up to 48 kHz. The SBC codec is mandatory; codecs such as mp3, AAC, apt-X and others are optionally supported.

AG
: is the duplex Audio Gateway role, used in HFP and HSP. AG is the node (such as a car kit) that mediates between the user and the mobile phone.

apt-X
: is an optional high-performance codec used in A2DP.

AT command
: is an audible signal used to control a device. AT commands are a PSTN (Public Switched Telephone Network) legacy.

AVRCP
: is the "Audio/Video Remote Control Profile." This profile is used in conjunction with A2DP, and pro-

vides “transport” controls such as Play, Pause, Reverse, Forward, etc. Roles are Controller and Target.

Connect
Paired devices can connect using compatible profiles and roles. Connection enables exchange of audio or control data. Each device can connect with only one device at a time.

CVSD
is Continuously Variable Slope Delta modulation, the codec used in HSP and legacy HFP profiles. With HFP 1.6, higher data rates enable the use of a higher quality codec called mSBC.

Device address
Every Bluetooth device has a unique 48-bit device address, in APx500 displayed in hex format, such as 00:f4:b9:c3:a0:cc.

Device class
A Bluetooth device class is a code that identifies the type of device. Some Bluetooth devices will only recognize devices of a certain class.

Discovery
Bluetooth devices that are not paired can discover each other when they are in range. Some devices allow users to make the device undiscoverable.

duplex
refers to a bi-directional audio channel, across which speaking and listening can occur simultaneously.

eSCO
Extended SCO, available in the Bluetooth 1.2 specification. Adds new packet types (EV1, etc.) and more flexibility in channel parameters, allows retransmission of bad packets. Also see SCO.

EV1
First of a series of packet types available with eSCO, as opposed to the HV1, etc. packet types in SCO.

Friendly name
is an optional name for a Bluetooth device, more easily understood and remembered than the device address. An example is “iPhone”.

HF
is Hands Free, the duplex “phone” role in the HFP profile.

HFP
is the Hands Free profile, intended to allow hands-free device operation in an automobile. It is similar to HSP, with more phone controls. Roles are AG and HF.

HFP 1.6
is a revision of the HFP specification, which allows new packet types and higher data rates compared to legacy HFP. These data rates and newly supported codecs such as mSBC enable WBS (Wideband Speech) performance.

HS
is Head Set, the duplex “phone” role in the HSP profile.

HSP
is the Head Set profile, intended to enable Bluetooth mobile phone use. Roles are AG and HS.

HV1
First of a series of packet types available with SCO, as opposed to the EV1, etc. packet types in eSCO.

Link key
is a shared secret exchanged in pairing.

mSBC
is a monaural version of the SBC codec, optimized for use in the HFP 1.6 profile. This codec and the higher available sample rates enable Wideband Speech operation.

Pair
Bluetooth devices that have discovered each other can be paired by exchanging a link key to form a bond. For some devices, pairing is automatic upon discovery; for others, user interaction is required. Pairing establishes a mutual, secure relationship between devices that have at least one compatible profile. Pairing is stored in non-volatile memory in each device. Devices can pair with more than one other device.

PIN code
A Personal Identification Number embedded in a device or provided by a user that is exchanged in a pairing negotiation.

Profile
One of a number of defined Bluetooth relationships covering a range of devices and use cases. A device can support more than one profile, and devices can be paired acknowledging more than one profile.

role
A role is a defined use of a device within a profile. In A2DP, for example, the roles are source and sink. For HFP, the roles are AG and HF.

SBC
(Sub-band Codec), the mandatory codec for the A2DP Profile. Other codecs are allowed.

SCO
is a synchronous connection oriented channel, a full duplex data channel with 64 kbit/s data rate in each direction. The CVSD codec is used, and the three HV types of data packets are available. Also see eSCO.

sink
is the term used for the device that receives audio in a uni-directional system.

source
is the term used for the device that transmits audio in a uni-directional system.

SSP
is Secure Simple Pairing, the pairing methods required in Bluetooth v2.1. Audio Precision supports the SSP Just Works, Numeric Comparison and Passkey Entry methods.

Per FCC 15.19(a)(3) and (a)(4) This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Per FCC 15.21, CAUTION to the USER- changes or modifications not expressly approved by AUDIO PRECISION (the party responsible for compliance) could void the user's authority to operate the equipment.

8.4 User Manual Notice for Licence-Exempt Radio Apparatus

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

(1) This device may not cause interference; and

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

8.4 Manuel de l'utilisateur Avis pour un appareil radio exempt de licence

Cet appareil est conforme aux normes RSS exempts de licence d'Industrie Canada.
L'opération est soumise aux deux conditions suivantes:

(1) Cet appareil ne doit pas provoquer d'interférence; et

(2) Cet appareil doit accepter toute interférence, y compris les interférences susceptibles de provoquer un fonctionnement indésirable de l'appareil

NOTICE TO THE USER - This equipment is intended to be used only with the Antenna originally supplied. Do NOT susitute or replace the Antenna with a different type or design. Contact Audio Precision to order a replament Antenna - AP part Number for a replacement Antenna is 4543.5024

NCC 警語低功率電波輻射性電機管理辦法第十二條經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。第十四條低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。前項合法通信，指依電信規定作業之無線電信。低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾
在5.25-5.35 秭赫頻帶內操作之無線資訊傳輸設備，限於室內使用。