DOCUMENT NUMBER M-20869-001

Ezairo® 7111 V2 Pre Suite Getting Started Guide

1. INTRODUCTION

Ezairo 7111 V2 Pre Suite is a comprehensive turnkey solution for hearing aids. The Ezairo 7111 V2 firmware provides numerous feature enhancements while still using the Ezairo 7111 hybrid hardware. Using the various tools described in this document, Ezairo 7111 V2 Pre Suite greatly simplifies the development of hearing-aid products. This document provides a guide for getting started with Ezairo 7111 V2 Pre Suite, illustrating interaction of the system components and required tools.

2. PRODUCT OVERVIEW

Ezairo 7111 V2 Pre Suite is comprised of the Ezairo 7111 hybrid module and the Ezairo 7111 V2 Firmware Bundle. The product is configured using Sound Designer Software, the Ezairo 7111 Hybrid Demonstrator Board, and a programming box that provides PC-to-device communications. The following sections provide a brief overview of each component. Figure 1 illustrates a typical evaluation and development setup.

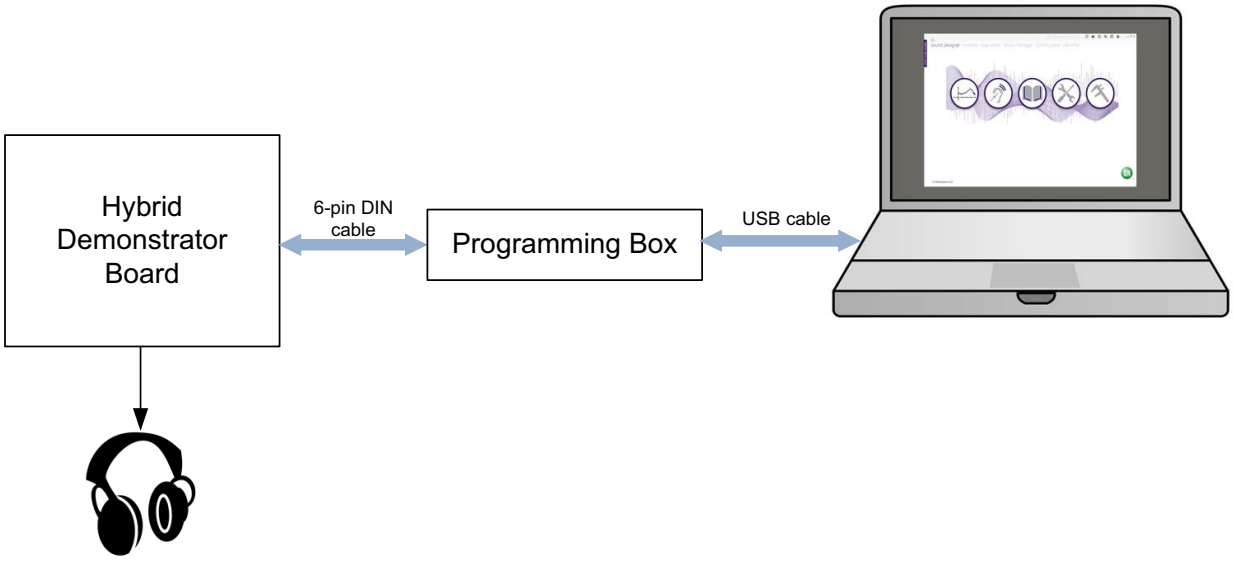


Figure 1. Typical Evaluation and Development Setup

2.1 Ezairo 7111 V2 Hybrid Module

Ezairo 7111 is an open-programmable DSP-based hybrid module specifically designed for high-performance hearing aids. The Ezairo 7111 hybrid is comprised of: the Ezairo 7100SL System-on-Chip (SoC) audiology processor; EA2M, a 2 Mb EEPROM; and all necessary passive components for operating the sub-system and interfacing with hearing aid transducers.

A hearing-aid connection diagram using the Ezairo 7111 hybrid and the Pre Suite firmware is shown in Figure 2 on page 2.

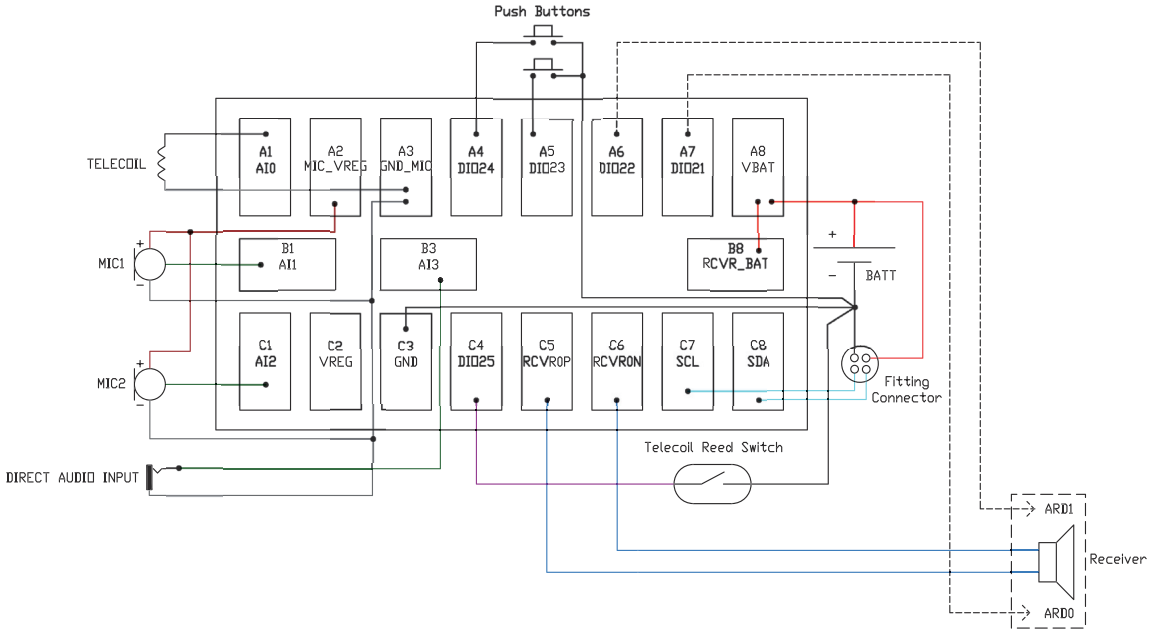


Figure 2. Ezairo 7111 Typical Connection Diagram

Full details for the Ezairo 7111 hybrid module can be found in the Ezairo 7111 data sheet.

2.2 Ezairo 7111 V2 Firmware Bundle

The Ezairo 7111 V2 Firmware Bundle implements all the features required for an advanced hearing aid. These are listed in Table 1, below.

Table 1. Ezairo 7111 V2 Firmware Features

Feature	Description
Audio bandwidth	All features in the audio path, from microphone inputs to the receiver output, operate at a sample frequency of 24 kHz, providing an audio bandwidth of 12 kHz.
16-channel WDRC with in-channel limiting	Fully adjustable WDRC that provides independent compression in up to 16 channels. Each channel provides a compression curve with four separate knee points: expansion, low-level gain, high-level gain, and output limiting. Dynamic behavior covers a wide range through adjustable time constants.
Wideband limiter (AGCo)	Adjustable wideband gain with integrated fast-acting compression limiting.
48-band graphic Equalizer (EQ)	A graphic EQ provides an independent gain adjustment in each of the 48 separate frequency bands. Gains can be adjusted from -18 to +18 dB.
Adaptive Feedback Canceller Second Generation	Advanced, multiband feedback canceller with independent operation in each frequency band. A rich set of controls are provided to allow tuning over a wide range of acoustic conditions. An optional gain management feature further augments the canceller to minimize the occurrence of feedback events.
Adaptive noise reduction	Attenuates noise independently in 48 frequency bands. Maximum attenuation is adjustable in each frequency band up to a maximum of 15 dB.

Table 1. Ezairo 7111 V2 Firmware Features (Continued)

Feature	Description
Adaptive Directional Microphone	Synthesizes a directional microphone pattern from two omnidirectional microphones (front and rear). Automatically steers/adjusts the microphone pattern to minimize interfering noise sources. The directional block includes an optional low-frequency boost to equalize the directional microphone response.
Telecoil and Direct Audio Inputs (DAI)	An additional auxiliary input can be configured as telecoil or DAI. Automatic telecoil activation is supported through external reed switch.
Environment Classification	Automatically classifies the acoustic environment and activates the appropriate program memory. Detection characteristics are adjustable, and the behavior of the device in each environment is completely flexible. Supports quiet, speech in quiet, noise, speech in noise, wind, and music.
8 Program Memories	The device supports up to 8 program memories with independent parameters. Selection of the active memory can be performed by using push-button controls, or via the environment classifier feature.
General Purpose Filters	Eight general-purpose digital filters are provided for fine tuning the audio path. Each of the eight filters are second-order, Infinite Impulse Response (IIR) filters (also called biquads). Four filters (pre-biquads) are placed near the input stage, ahead of the WDRC processing; and four filters are placed near the output stage, after the WDRC processing. Filter coefficients are completely programmable via Sound Designer Software.
Datalogging	A short-term data log periodically records device status and system events into a circular buffer. A total of 512 events can be logged in the buffer which, assuming a log interval of 1 hour, covers a total time period of over 4 weeks. A separate long-term data log keeps track of how much time has been spent in each program memory.
Automatic Receiver Detection (ARD)	The ARD feature is intended for detachable RIC-style hearing aids. It provides a means of automatically detecting the type of attached receiver link. ARD operates in real time and provides rapid detection of the connected receiver link with no audible artifacts.
Firmware updates	The Pre Suite framework supports field upgradeable firmware.
Sound Generator for Tinnitus Treatment	Consists of a random noise generator with adjustable frequency shaping and randomized time modulation for tinnitus treatment.
Configurable Man-Machine Interface (MMI)	The MMI feature supports a push-button style volume control (up/down presses), an 8-program memory select function, and an automatic telecoil activation feature. Operation of the MMI is fully configurable, and the IO pins used for the MMI functions are selectable through the Sound Designer Software Windows application. Twenty-one different system events are signaled through an acoustic indicator feature that supports both tone-based and pre-recorded alert signals.
Fitting	All device parameters can be accessed over the wired interface via the Sound Designer SDK. By providing a consistent API across multiple platforms, the Software Development Kit simplifies the development of fitting software.
Diagnostics	The Ezairo 7111 V2 firmware bundle also provides numerous features designed to simplify hearing-aid design and manufacturing. These features include battery management, live display data, tone generation, and feedback-path measurement.

The main features are illustrated by the block diagram shown in Figure 3 on page 4.

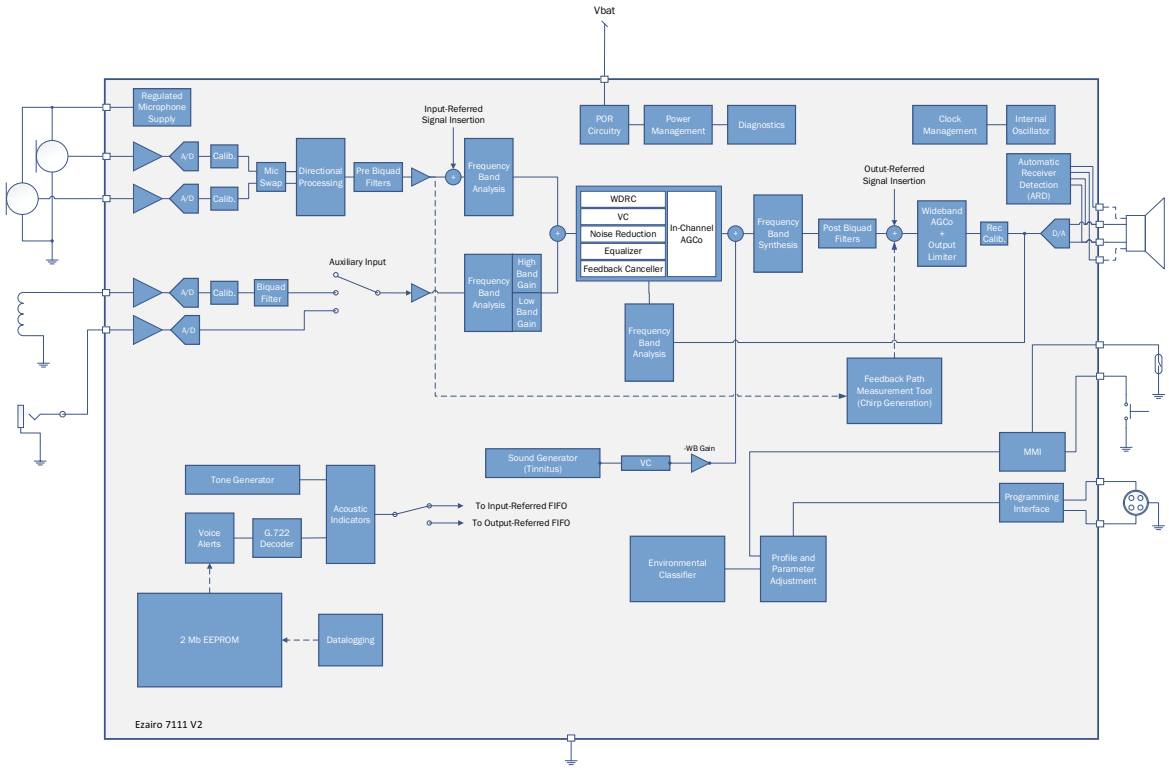


Figure 3. Ezairo 7111 V2 Firmware Bundle Block Diagram

Full product information is provided in the *Ezairo 7111 V2 Firmware Bundle User's Guide*, which is included with the Sound Designer Software Windows Application.

2.3 Sound Designer Software

The Ezairo Sound Designer Software Application is an engineering tool that allows Hearing Aid manufacturers to configure any Pre Suite Firmware bundle and derive several different Hearing Aid end products. Sound Designer Software consists of the Sound Designer Software Windows Application and the Sound Designer Software Development Kit (SDK).

The Sound Designer Software Application provides a complete desktop environment for hearing aid design. It integrates a device modeler, parameter map editor, product library manager, device control panel, and a calibration and configuration utility. This allows hearing aid manufacturers to create, configure, and test hearing aids more efficiently, with less time spent on repetitive tasks. The application's menu is shown in Figure 4 on page 5.

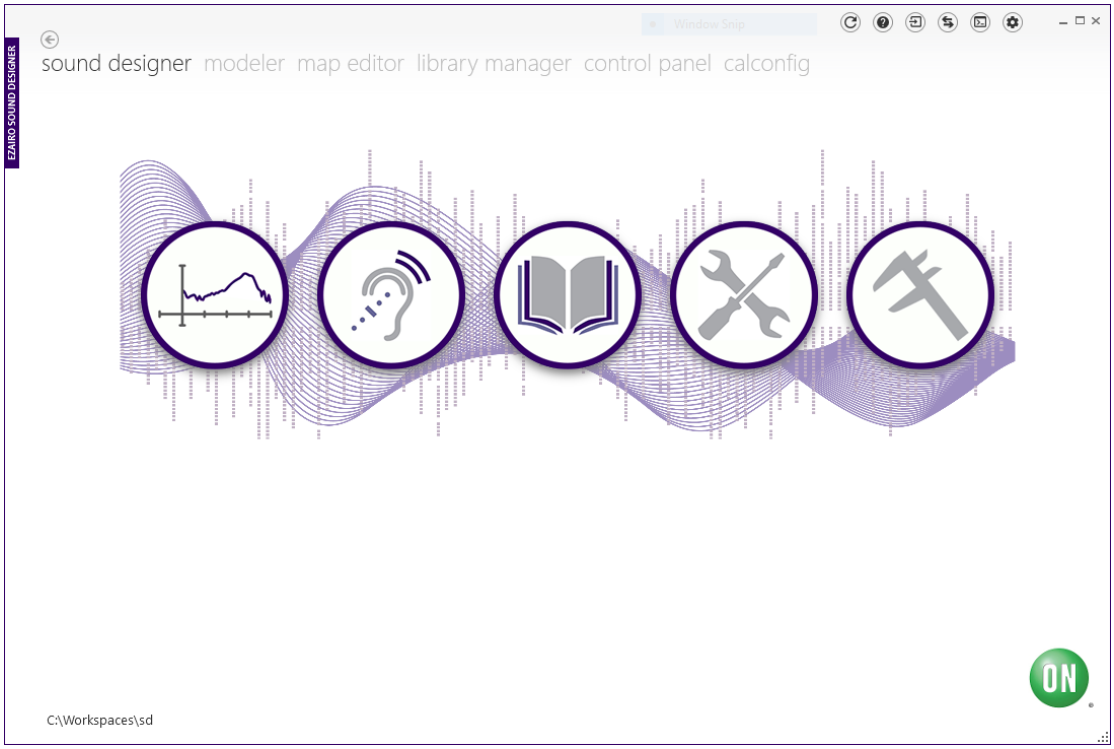


Figure 4. Sound Designer Software Application Opening Menu

The Sound Designer SDK is a cross-platform library that provides an interface to the hearing aid modeling and control functions. By providing a consistent API across multiple platforms, it simplifies the development of fitting software targeting the Ezairo 7111 V2 Pre Suite product. The SDK distribution file also contains sample mobile applications for iOS, Android and Xamarin, to facilitate the development of mobile applications that work with the Ezairo 7111 V2 Pre Suite and Windows sample code.

A complete reference guide for the Sound Designer Software Windows Application is provided upon installation of the software (see below for installation instructions). An SDK reference guide is included with the SDK distribution package.

2.4 Hybrid Demonstrator Board

The Hybrid Demonstrator Board is designed to be used with the Ezairo 7111 V2 Pre Suite firmware bundle to develop hearing aids based on Ezairo 7111. The board features many configuration options available via standard 0.1 inch header pins. The Ezairo 7111 demonstrator board also features a socket for housing the Ezairo 7111 hybrid module. This allows easy replacement of the Ezairo 7111 module during development, testing and debugging.

The picture and the configuration options are described in Section 3.3, “Configuring the Hybrid Demonstrator Board” on page 8.

2.5 Programming Box

When using the Ezairo 7111 Hybrid Demonstrator Board, a programming box interface is provided through a 6-pin DIN connector that is mounted on the board. A 6-pin DIN to 6-pin DIN cable is also provided, allowing direct

connection to the programming box. This connector is compatible with the connections provided on most of the programming boxes listed in Table 2, with the exception of the Promira. When using the Promira, use the 6-pin DIN to 34-pin header adapter, provided with the Ezairo 7111 Hybrid Demonstrator Board.

Communicating with a device requires an I^2C connection between the Windows PC and Ezairo 7111. The I^2C interface is provided by one of a number of different programming boxes that are compatible with Sound Designer Software. Supported devices are listed in Table 2.

Table 2. Supported Communication Interfaces and Protocols

Interface	I^2C	Wireless
Communication Accelerator Adaptor (CAA)	X	
HiPro	X	
DSP3	X	
Promira Serial Platform	X	
NOAHlink	X	

Sound Designer Software works with any of the programming boxes listed above. In addition, you must ensure that the Windows drivers provided by the manufacturer have been installed prior to using Sound Designer Software. Windows drivers for the various programming boxes are available from the manufacturers listed below in Table 3.

Table 3. Windows Programmer Drivers and Their Manufacturers

Inferface	Manufacturers of Drivers
HiPro2	Otometrics
Promira	TotalPhase Inc.
CAA	ON Semiconductor
DSP3	ON Semiconductor

3. Initial Setup

This section describes the initial setup for evaluating the Ezairo 7111 V2 Pre Suite. This includes downloading and installing the Sound Designer Software Windows application, configuring the Ezairo 7111 Hybrid Demonstrator Board, and connecting the programming box. The description is intended for first-time users. If you have already completed the initial setup, you can proceed to Section 4.2.1, “Audio Path Configuration” on page 16.

3.1 Prerequisites and Software Downloads

Before attempting to install Sound Designer Software, ensure that the computer meets the following minimum requirements:

- Hardware
  - Processor: 1 GHz
  - Memory: 512 MB RAM
  - Display: 16-bit color, 1024x768 screen resolution
  - Hard Drive: 150 MB of free space
  - Peripherals: communications interface for connecting to the Hybrid Demo Board (typically a serial or USB port - see below)

- One of the following versions of Microsoft® Windows®:
  - Windows 7 with Service Pack 1 (32-bit or 64-bit)
  - Windows 8.1 (32-bit or 64-bit)
  - Windows 10 (32-bit or 64-bit)

- For running the code samples:
  - CTK
    i. Microsoft® Visual C++ 2010 SP1 Redistributable Package (x86) (vcredist_x86.exe) available here: SoundDesignerSDK/redistribution/MS VC++ 2010 Redist (x86). The installation of this redistributable is required for CTK.
    ii. CTK installer: SoundDesignerSDK/redistribution/CTK

  - Microsoft Visual C++ 2015 Redistributable Update 2 for 32-bit operating systems (vc_redist.x86.exe), available here: SoundDesignerSDK/redistribution/MS VC++ 2015 Redist (x86). Installation of this package is required for the SDK.
  - The prerequisites listed in the *README* files contained in the individual code samples' sub-directories. For example, to run the C# sample you need the Dot Net Core runtime (as indicated in the *README* file of that sample), in addition to the Visual Studio 2015 C++ redistributable.

To download Sound Designer Software, you require a MyON login account. If you do not have a MyON account, please contact your local ON Semiconductor sales representative.

To download the Sound Designer Software package, log into your MyON account and select the **Software** hyperlink from the main Ezairo 7111 landing page. From the pop-up menu, select **E7111_V2 Firmware, Sound Designer and SDK** to download the main *.ZIP* file. Unzip the file contents to a local directory and then follow the instructions below.

3.2 Installation Instructions

To install Sound Designer Software, follow these steps:

1. Double-click **sounddesigner_setup.exe**. Follow the prompts for installing the software on your computer. When installation is complete, the Sound Designer Software can be launched from the **Start** menu under **ON Semiconductor** > **Sound Designer** > **Sound Designer**.
2. Select the appropriate programming box installation procedure from the following list:
   a. If you are using a DSP3 (from manufacturer ON Semiconductor), install the DSP3 Programmer driver version 2.1.71 (included in redistribution/DSP3).
   b. If you are using a HI-PRO (from manufacturer Otometrics), install the latest HI-PRO driver (currently version 4.02) from Otometrics®; add the following to your system path (found in the environment variables) to complete the HI-PRO programmer installation.

```
C:\Program Files (x86)\HI-PRO;
```

   c. If you are using a Promira™ Serial Platform (from manufacturer Total Phase), ensure that you are running firmware version 1.35 or later. Ensure also that your Promira is registered in the Device Manager under **Network Devices**, not under **Other Devices**. It might appear as **Remote NDIS Compatible Device**. When you plug in the Promira Serial Platform for the first time on a particular USB port, you need to wait for about two minutes to allow it to register before using Sound Designer Software. During registration, the blue light comes on, which normally indicates that the device is ready for use; however, if the registration is incomplete, Sound Designer Software cannot use Promira. See the *Promira Serial Platform System User Manual* from TotalPhase™ for more information.

3.2.1 Additional Sound Designer Software Features, Locations, and Installation

3.2.1.1 Documentation

Once the Sound Designer Software has been installed, you also have access to all the detailed technical documentation, such as the *Ezairo 7111 V2 Firmware Bundle User's Guide* and the *Ezairo Sound Designer Software User's Guide*. See the Documentation directory under the SD installation directory; and the Firmware Bundle documentation is also located in the SDK documentation folder. This documentation is not required at this stage, but is useful for more advanced device configuration.

3.2.1.2 Sample Code

As part of the Sound Designer Software Development Kit (SDK), you have access to an archive containing sample code for all operation systems supported by the Sound Designer Software API. Table 4 shows the types of code samples available and where to find them in the archive.

Table 4. Code Sample Types and Locations

Code Sample Type	Location
C# sample in the form of Dot Net Core tests	*samples/win/cs*
COM samples in the form of API tests and a Win32 application	*samples/win/COM*
Python samples in the form of tests	*samples/win/python*
Xamarin for iOS sample app	*samples/ios/xamarin*
Swift for iOS sample app	*samples/ios/sdmobile*
Android sample app	*samples/android*

3.2.1.3 iOS and Android App Development Tools

Unzipping the Sound Designer Software Development Kit (SDK) gives you access to frameworks and libraries for developing iOS and Android apps, as described below in Table 5.

Table 5. App Development Tools in the Sound Designer SDK

Tool	Description	Location	More Information
iOS Sound Designer Software Frameworks	XCode app	*samples/ios/sdmobile*	*samples/ios/sdmobile/sdmobile/README.TXT*
	Xamarin app	*samples/ios/xamarin/ Framework*	*samples/ios/xamarin/README.TXT*
Android Sound Designer Software Libraries	Android software libraries and a demonstration app	*samples/android*	*samples/android/E7150SL_SDK_Demo/ README.TXT*

More details on the Sound Designer SDK and its features can be found in the *SDK Readme.html* file, located at the top level of the main *.ZIP* file.

3.3 Configuring the Hybrid Demonstrator Board

Before connecting the Ezairo 7111 Hybrid Demonstrator Board to the programming box, ensure that a functioning Ezairo 7111 hybrid is installed. Refer to the *Ezairo 7111 Hybrid Demo Board User's Manual* (EVBUM2533) for detailed instructions on how to install the hybrid. Once the hybrid is installed, ensure that the jumpers and power switch are configured as listed in Table 6. Full information on the jumper settings and other board options can be found in the *Ezairo 7111 Hybrid Demo Board User's Manual* (EVBUM2533).

Table 6. Jumper Configurations for Ezairo 7111 Hybrid Demonstrator Board

Jumper/Switch	Required Setting	Description
PSU-SEL	Short pins 1&2	Draws power from 6-pin DIN connector
VBAT-I	Short pins together	Not measuring current
RCVR-EN	Short pins 1&2	Enable 7111V2 output drivers
RCVR-BAT	Leave open	Using onboard power
ON-OFF	Set to ON	Power switch for E7160

A properly configured Hybrid Demonstrator Board looks like the one shown in Figure 5. The correct settings are indicated by red rectangles.

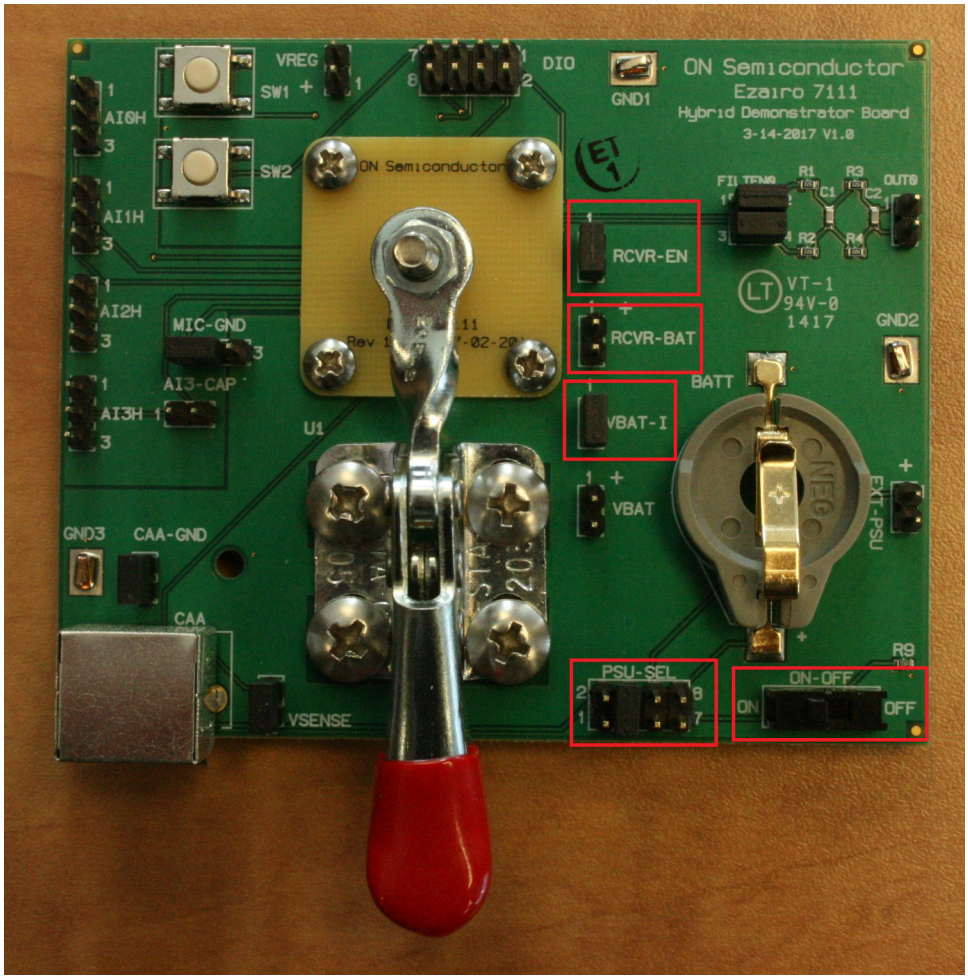


Figure 5. Properly Configured Ezairo 7111 Hybrid Demonstrator Board

3.4 Connecting the Programming Box

The programming box is connected to the Hybrid Demonstrator Board via the 6-pin DIN connector provided on the Hybrid Demonstrator Board. The programming box connection is either a similar 6-pin DIN connector, or in the case of the Promira, a 34-pin header adapter.

Next, connect the programming box to the PC using a USB cable. The fully connected system appears as shown in Figure 6.

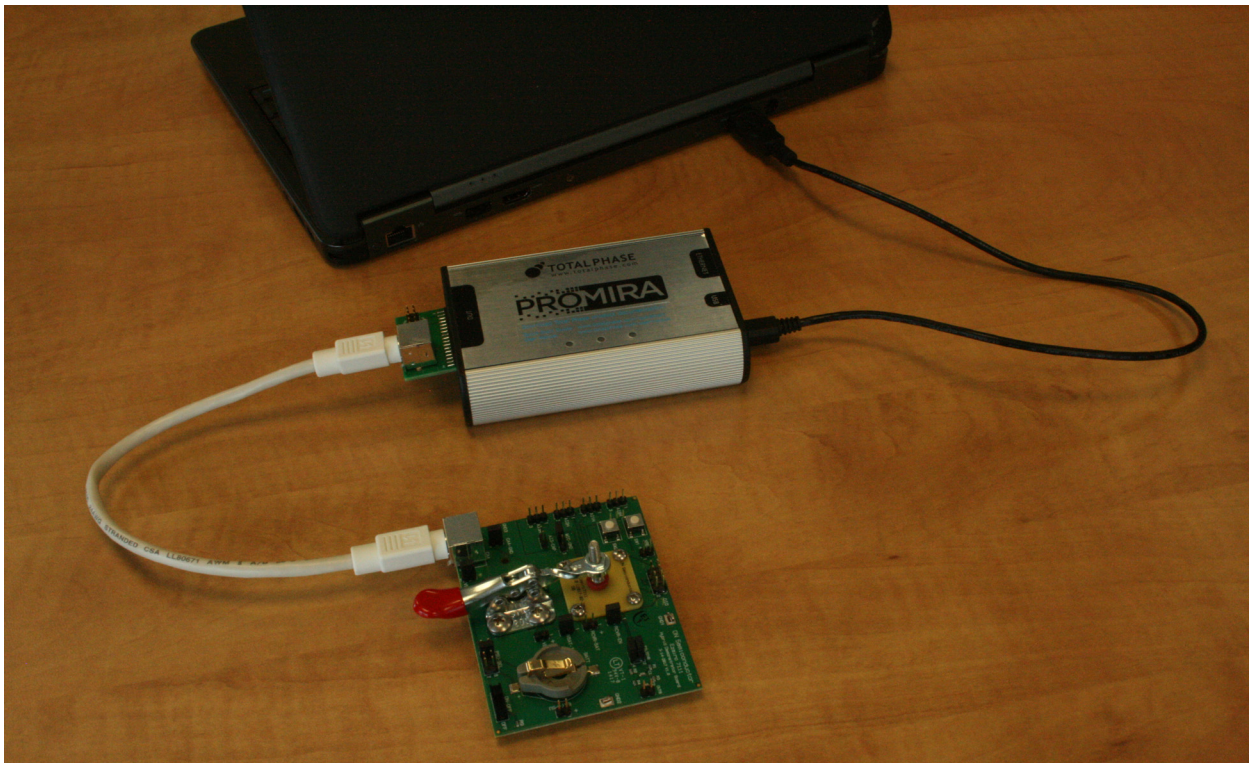


Figure 6. Connected Ezairo 7111 V2 Hybrid Demonstrator Board, Windows PC, and Programming Box

Once the system is connected, you can perform the initial communication from the PC to Ezairo 7111 (device connection).

4. Working with the Sound Designer SDK

4.1 Connect to Device

NOTE: The Ezairo Pre Suite firmware bundles are embedded within the Sound Designer Software. Options for selecting the appropriate firmware are provided upon initial connection to a device.

To establish a connection with the device, follow these steps:

1. Power on your device by plugging in the programming box and moving the Hybrid Demonstrator Board ON-OFF switch to the ON position (if not already done).

2. Start Sound Designer Software by clicking on the **Sound Designer** link under the **ON Semiconductor** tab on the Windows **Start** menu.
3. When the **Select a Workspace** dialog box appears, you need to choose a workspace to for Sound Designer Software. For new installations, we highly recommend selecting an empty directory for the workspace. Errors might occur if opening a workspace created using an earlier version of the Sound Designer Software Application. To create a workspace, click **Browse** and the software allows you to create one. If you click **Browse** and select a pre-existing directory for your workspace, make sure it is empty. To begin working with the Ezairo 7111 V2, check **Import Sample Workspace**, and select **E7111V2** from the drop-down list. Click **OK**. (See Figure 7 on page 11

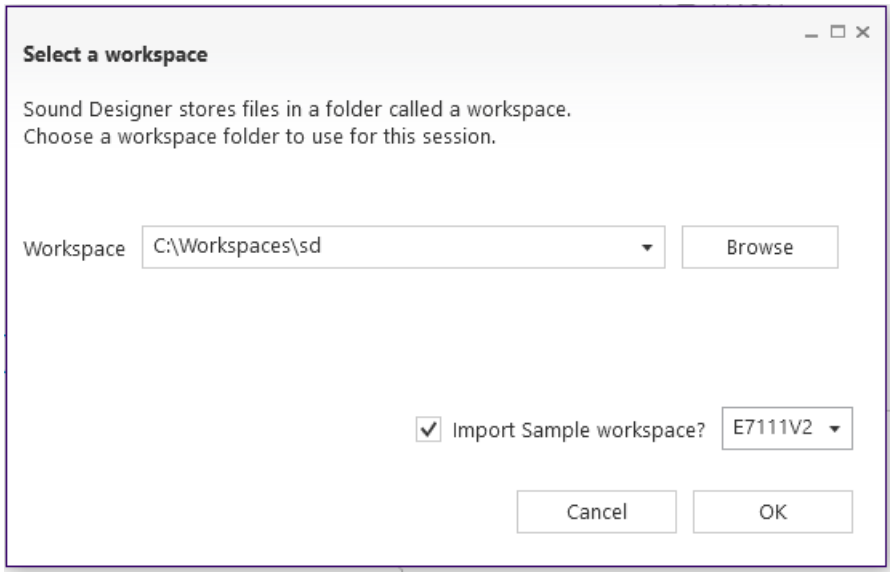


Figure 7. Selecting a Workspace

IMPORTANT: If you experience problems, such as an error opening a map file, when you use a workspace that has been created for an older version of Sound Designer Software, try creating a new workspace.

4. Optionally, open the console window by clicking the Show Console icon (shown in Figure 8, below). The console window displays error and status messages accumulated in this session. We recommend having the console viewable at all times while using Sound Designer Software, to get immediate status information.

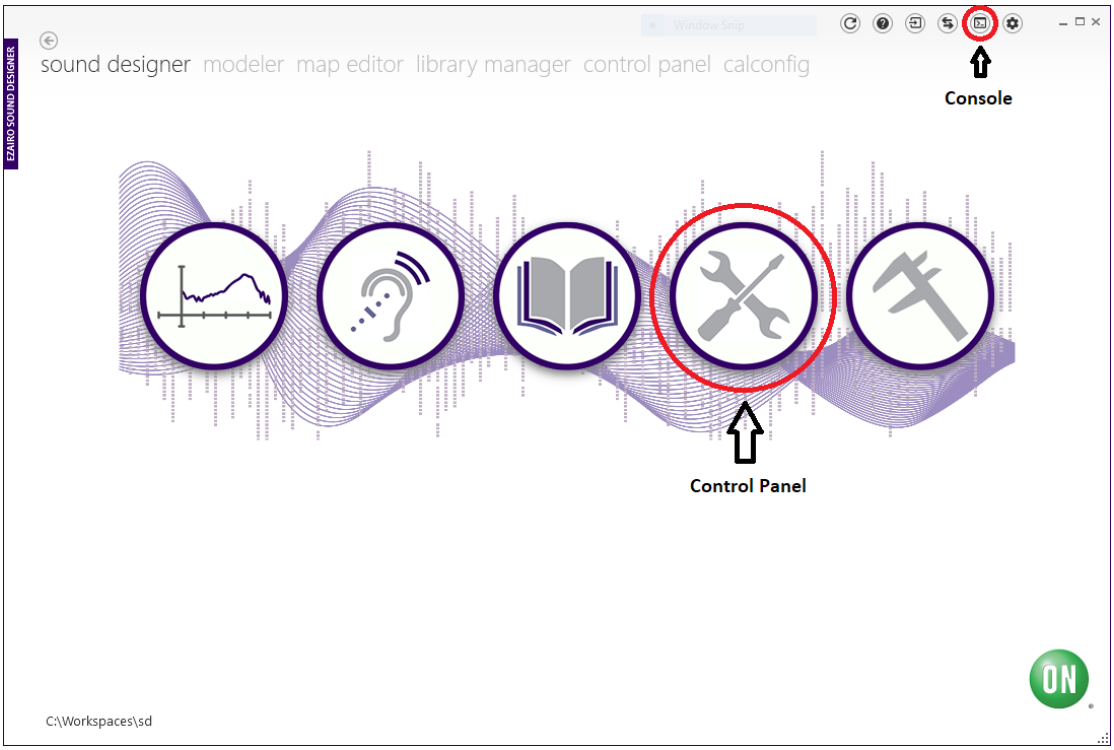


Figure 8. Opening the Control Panel and the Console Window

5. To configure device parameters, click on the **Control Panel** icon (circled in red in Figure 8, above) and, when prompted, double-click the **Ezairo7111V2.param** sample parameter file to open the demo product library, as shown below in Figure 9 on page 13.

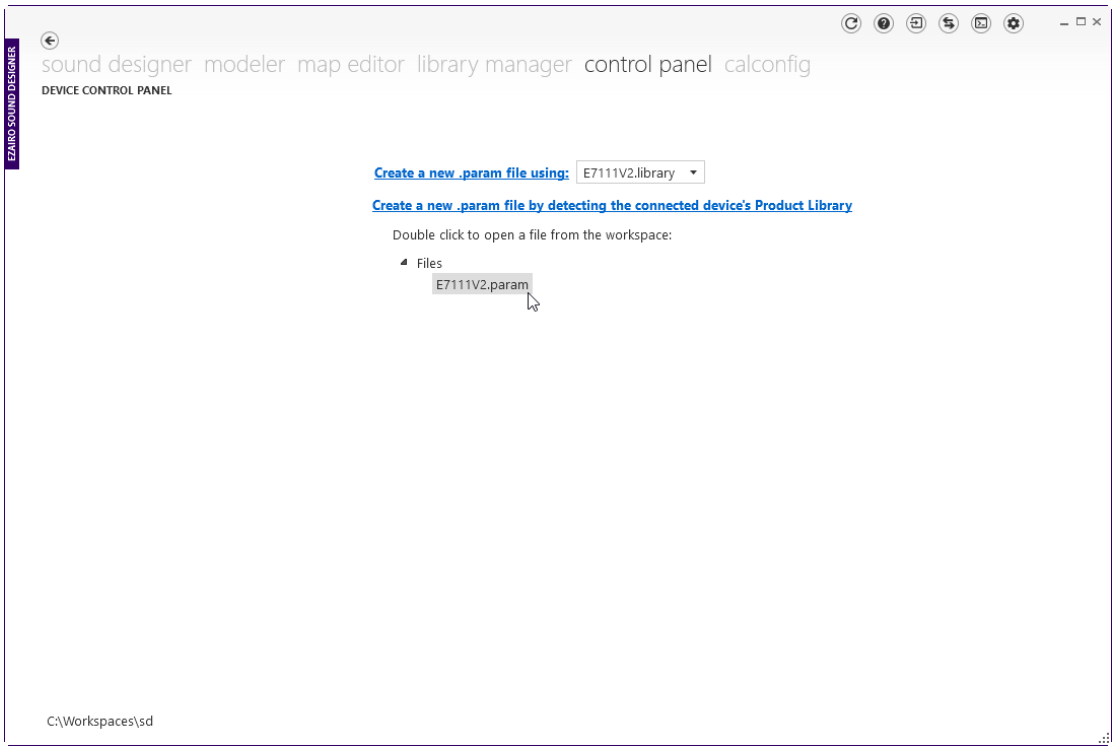


Figure 9. Selecting the Parameter File

6. To connect to the device, go to the **Settings** screen. Select the correct **Programmer**, and **Port** if applicable. Next, click **Detect**. A successful detection populates the device information in the **Device Info** box, as shown in Figure 10 on page 14.

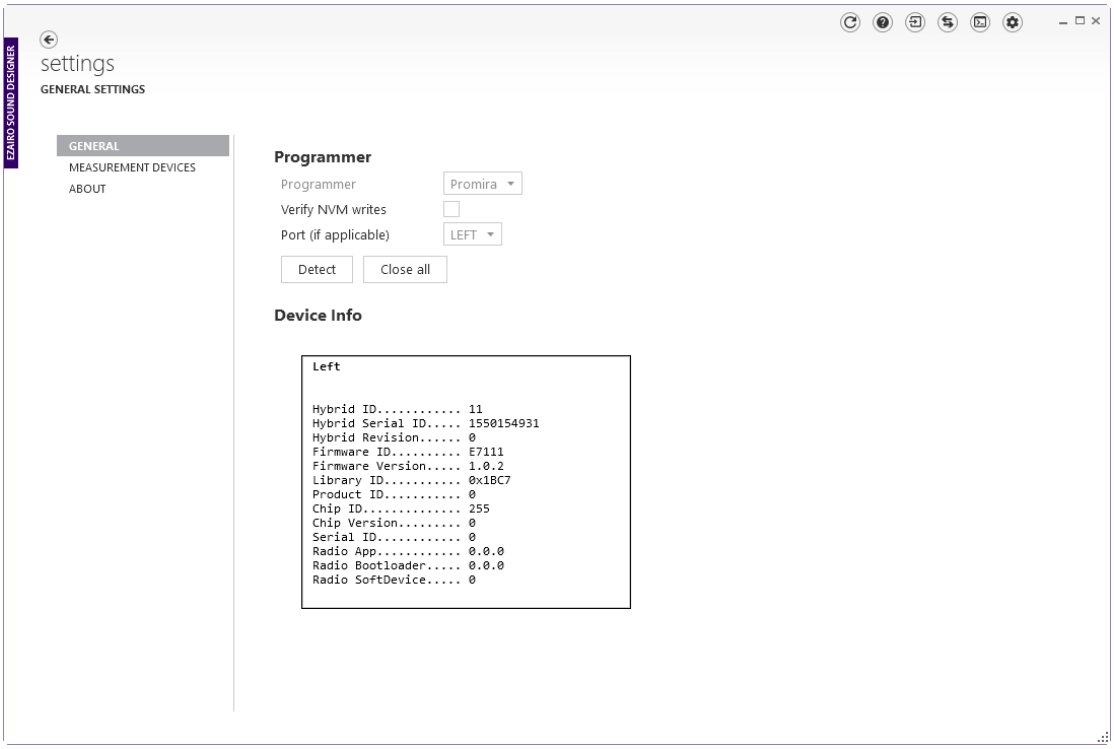


Figure 10. Detecting the Device

7. Use the back button—the arrow in the top left corner—to return to the Control Panel.
8. To connect to the device, click **Programmer** > **Connect**. You might get a popup warning you that the device is configured with another library. If you see this pop-up, click **OK**.
9. Before communicating any parameter information, Sound Designer Software checks the device to determine the firmware version currently residing in NVM. If the current version (contained within Sound Designer Software) is not the same as that currently in the device, you are prompted to upgrade the firmware. The prompt screen looks similar to that shown in Figure 11 on page 15.

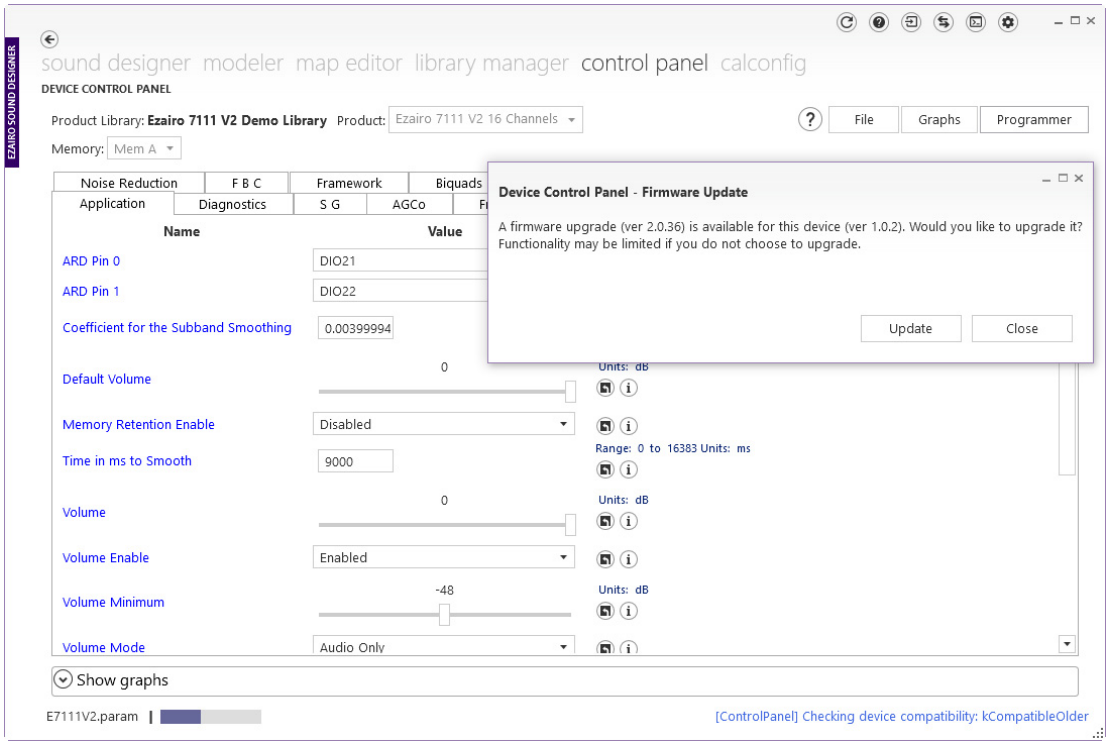


Figure 11. Upgrading the Firmware

10. Once the connection succeeds, the connection status symbol appears to the right of the file name, as shown below in Figure 12 on page 16. You can hover over this symbol to view the programmer name and the firmware ID of the device. It is now possible to configure the device parameters.

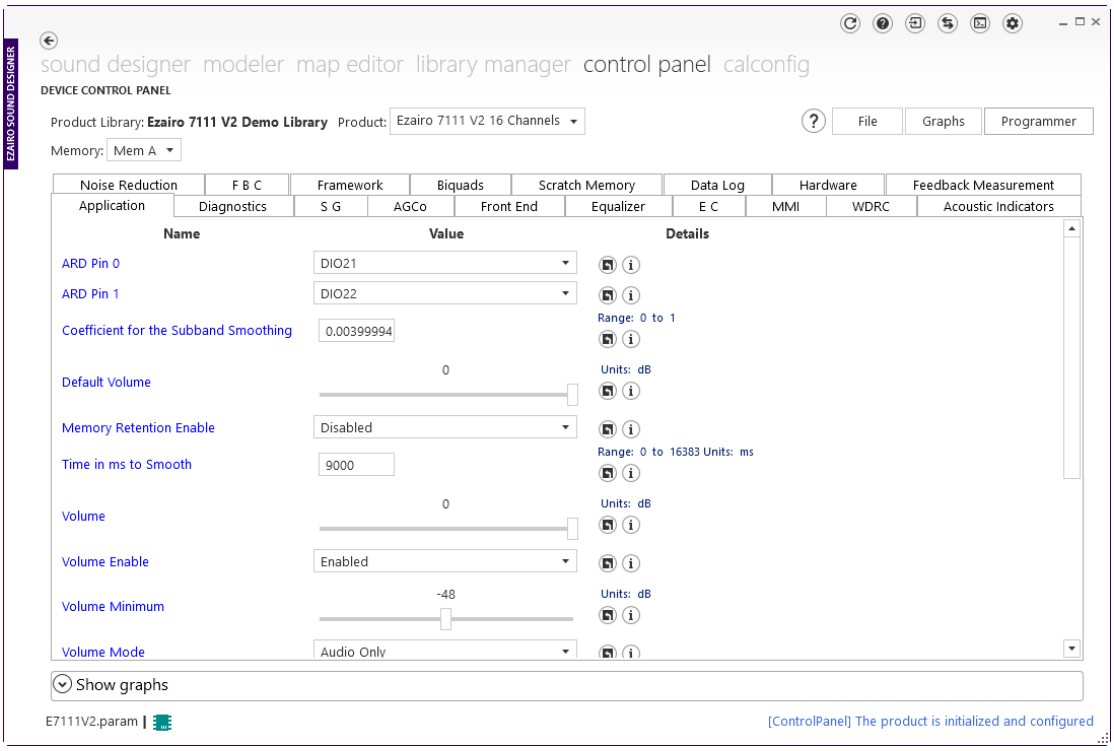


Figure 12. Successful Connection

4.2 Example Operations

4.2.1 Audio Path Configuration

Once connected to a device, it is possible to read, write and burn parameters to the Ezairo 7111 internal NVM. The steps below illustrate how to configure the built-in sound generator to generate an audio signal from the Ezairo 7111.

4.2.1.1 What You Need

Before beginning, you need to connect headphones or some other audio equipment to the output of the Ezairo 7111 Hybrid Demonstrator Board. Please refer to the *Ezairo 7111 Hybrid Demo Board User's Manual* for details.

The direct audio output from Ezairo 7111 is a pulse density modulated signal that can be used to directly drive hearing aid receivers or high impedance headphones. It is available on pins 2 and 4 of the header pins labelled `FILTEN0`.

The Demonstrator Board also provides a low-pass filtered output that is more appropriate for connection to sound cards and other audio equipment. The filtered output is enabled by connecting jumpers across pins 1 and 2 and 3 and 4 of header pin connector labelled `FILTEN0`. The filtered audio output is then available across pins labelled `OUT0`.

4.2.1.2 Enable the Sound Generator

If you are using a new device for the first time, all parameters need to be set to their default settings, as shown in the *E7111V2.param* file. If you are uncertain of the device state, or to ensure that the Sound Designer Software parameters are consistent with those stored in the device, you can perform a **Burn All to NVM** operation. This operation burns all default parameters from the current parameter file into NVM on the device, ensuring consistency with Sound Designer Software.

In the default configuration, only a basic audio path is configured. The front microphone input is enabled but the preamplifier gain is set to 0 dB. All advanced features are disabled. At this point, no audio signal is observed at the device output.

To generate an audio signal, follow these steps:

1. Select the **SG** tab in the Control Panel window.
2. Ensure that the **SG Bandwidth** parameter is set to 250 Hz + 11750 Hz per sideband.
3. Ensure the **Pre-Channel Level** is set to -40 dB.
4. Enable the sound generator by selecting **Static** from the drop-down menu for the **Enable Mode** parameter. The Control Panel screen needs to look like Figure 13, below:

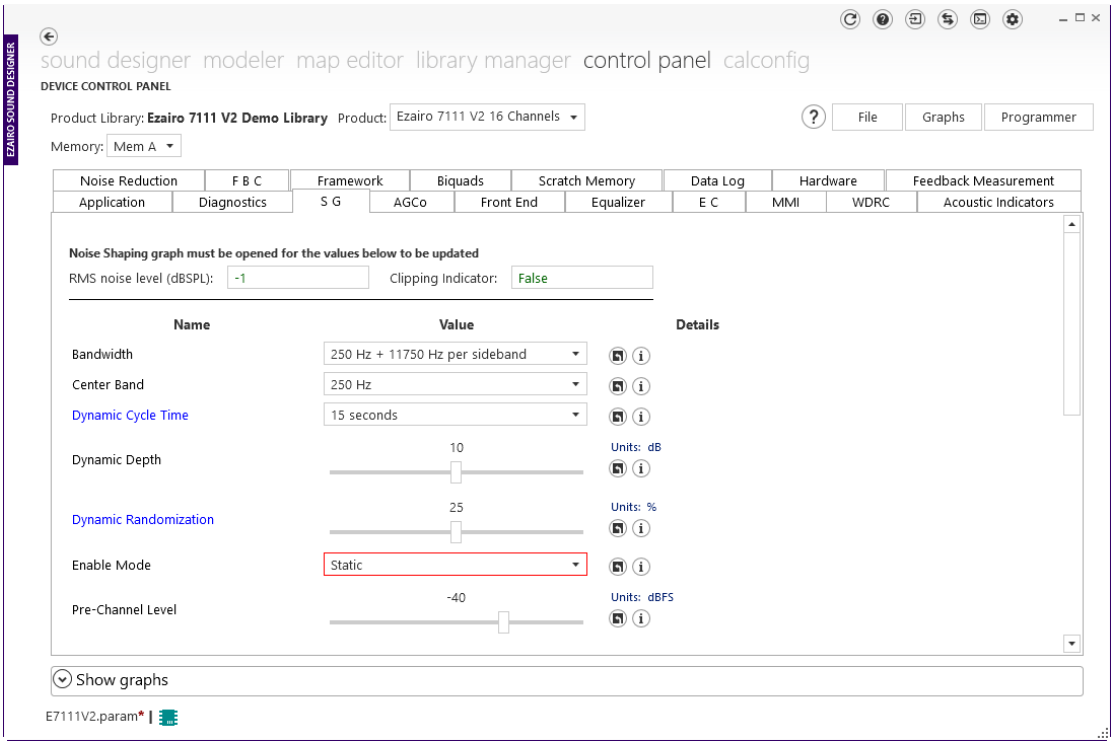


Figure 13. Enabling the Sound Generator

5. Click the **Programmer** button and select **Write to RAM**.
6. A white noise signal is now observable at the output of the device.
7. To disable the sound generator, select **Disabled** from the drop-down menu for the **Enable Mode** parameter and write that to RAM. The noise signal is now off.

If you can hear an audio signal from your device, then your system has been configured correctly. You can now use a similar procedure to modify other device parameters. For full details on the various features, refer to the *Ezairo 7111 V2 Firmware Bundle User's Guide*.

5. Further Reading

For additional technical details and more information regarding firmware bundle algorithm parameters, refer to the following resources:

- *Ezairo 7111 V2 Firmware Bundle User's Guide*
- *Ezairo® 7111 V2 Pre Suite Getting Started Guide*
- *Ezairo Sound Designer Software Development Kit (SDK) Programmer's Guide*

These documents can be requested through your local ON Semiconductor representative or authorized distributor:

- The Ezairo 7111 Datasheet
- *Ezairo 7111 Hybrid Demo Board User's Manual*

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