CIRRUS LOGIC®

Lochnagar 2 User Guide

For firmware version: 1.0.0

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Lochnagar 2 User Guide
JAN '17
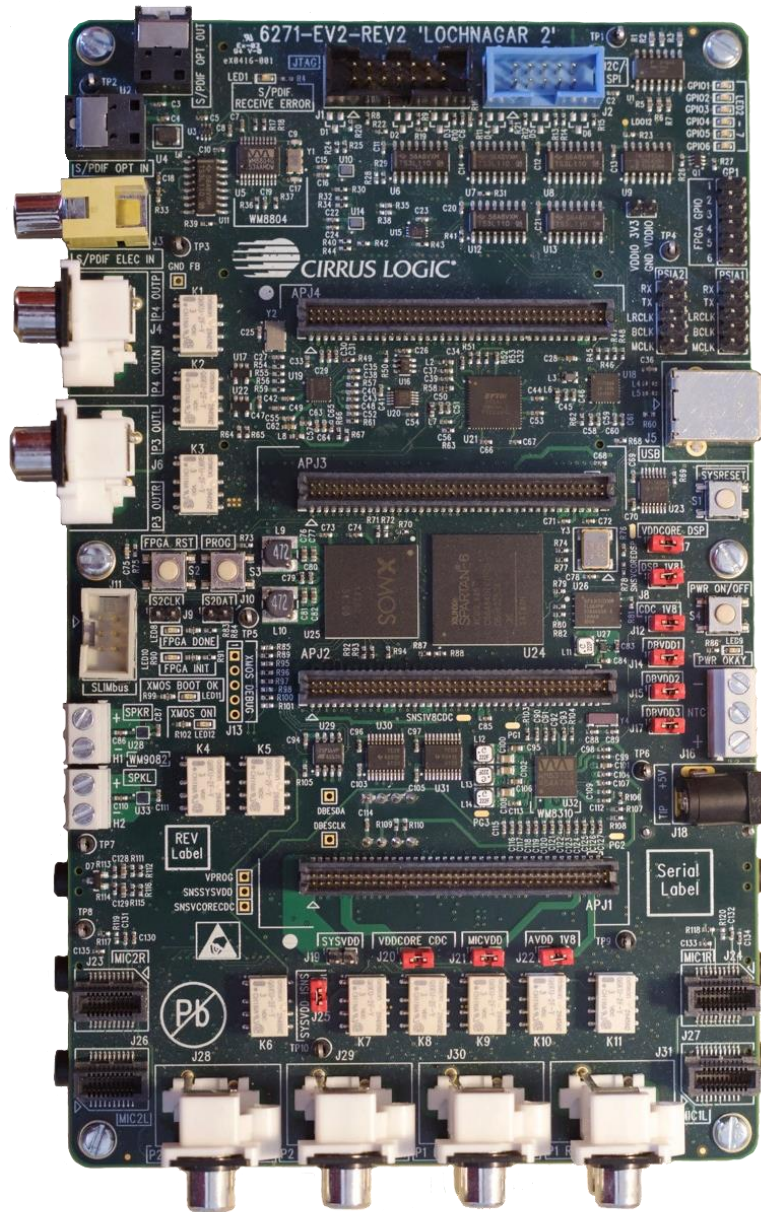
Contents

1 Introduction

Lochnagar 2 (6271-EV2) is the next generation evaluation and development board for Cirrus Logic Smart Codec and Amps devices. It is designed to provide a variety of audio inputs and outputs to the Cirrus devices and to allow for configuration and programming them in a variety of possible use cases.

Lochnagar 2 is the same form factor as the original Lochnagar board and is compatible with the same Smart Codec and Amp minicards. It provides all the same functionality as the previous generation, and in addition adds many new features and capabilities. This includes the ability to stream up to 16 channels of USB audio, and built-in current monitor feature that allows the power consumption of the Cirrus devices to be measured without any external equipment.

This document describes the features and usage of Lochnagar 2 in detail. The first two sections deal with the initial steps of hardware configuration and driver installation. The sections after this detail each of the features of the board and how to set it up in any potential use case. The final sections detail how to use the setup scripts provided with the Lochnagar 2 Device Pack and a guide on troubleshooting the board if any problems occur.

2 Hardware Connections

2.1 USB connection to PC

Lochnagar 2 is powered and controlled via a single USB connection. This provides:

- Power
- I2C/SPI communications to control device and board
- JTAG communications for DSP debug
- Multichannel USB streaming audio (USB class 2)
- USB serial port to communicate with Cirrus devices with UART interfaces

The board is provided with a Y-shaped USB cable, connecting a single USB B socket on Lochnagar 2 to two USB A ports on the computer (Black plug for power + communications, Red for power only). Both USB connectors must be plugged in to allow for the power consumption of the board.
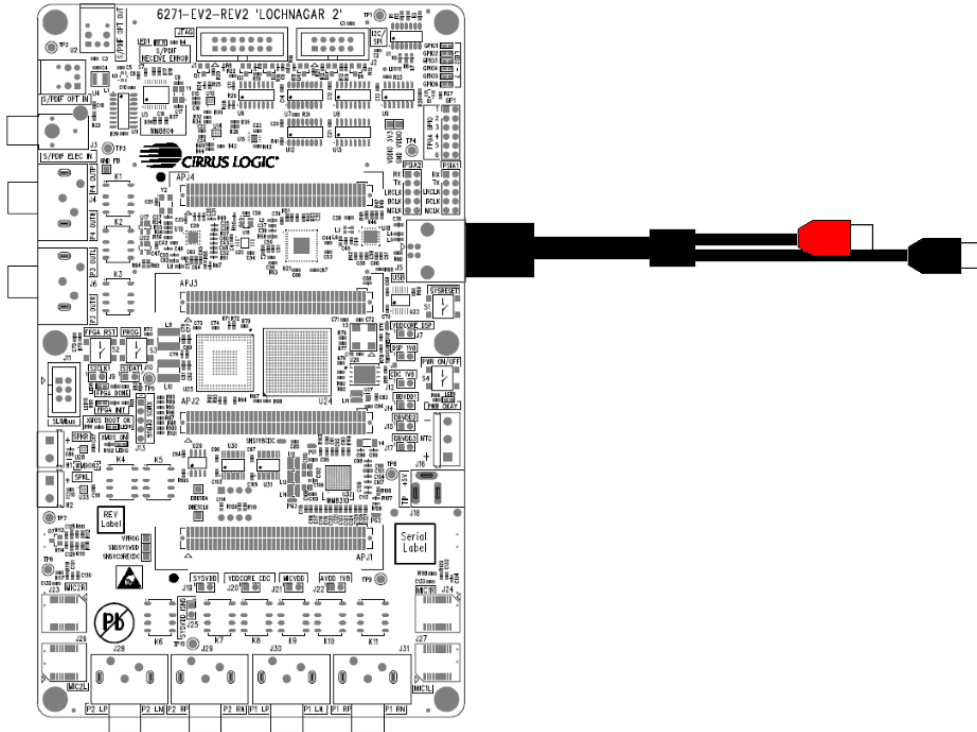
A Total Phase Aardvark connector is **NOT** required for Lochnagar 2 to operate, and neither does it require a separate power supply. All power and communications is provided to the board via this single USB link.

2.2 Power options

For most use cases, the provided USB cable is enough to power the entire board. In some scenarios, especially those using speakers, it may be necessary to plug a second power source into the Lochnagar 2 board. The onboard WM8310 PMIC will select the highest voltage from each of the three potential power supply inputs and use this to power the board's main SYSVDD bus. This is nominally 5V, but may be lower if a battery is used to supply the board.
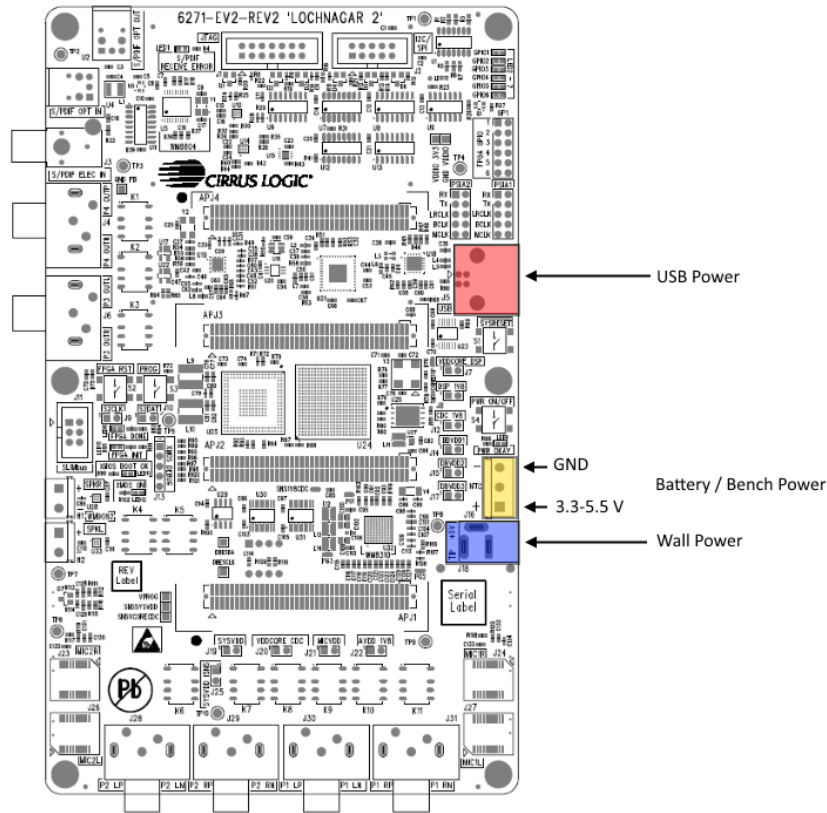
2.2.1 USB Power

As described in the USB Connection to PC section, this is the normal mode of operation for the Lochnagar 2 board. For most use cases, USB power alone is adequate and there is no need to connect any additional power supplies to the board.

To be certain of getting the full 900 mA maximum input current supported by Lochnagar 2 USB connection, it is vital to ensure that a Y-shaped dual-USB cable is used and that both ends are plugged in at the PC end. If a USB hub is used, then it is also important to use a self-powered USB hub with a wall power connection, as otherwise it may not be able to supply enough current.

2.2.2 Wall socket Supply

Lochnagar 2 provides a socket to accept 5V input from a dedicated wall supply.
It may be necessary to plug in the Wall supply as well as the USB connector for more power-hungry use-case scenarios such as those involving speakers.

The wall power connector J30 is positive tip (Tip = +5V), in contrast to the original Lochnagar board which used negative tip.

Protection diodes are fitted to prevent damage if a negative tip supply is inserted.

2.2.3 Battery / Bench Supply

Lochnagar 2 has three screw terminals which allow either a battery or a bench-top power supply unit to be plugged into the board.
It may be necessary to plug in a bench supply as well as the USB connector for more power-hungry use-case scenarios such as those involving speakers.

This input is nominally expected to be a 4.2 V battery, but the terminals can accept anything from 3.3 - 5.5 V. The terminals are marked with + and - symbols on the silkscreen to denote power and ground respectively.

Note that when the battery / bench supply is used as the sole power source for the board, the PWR ON/OFF button (S4) must be held down in order to power the board. This is in contrast to the other supply options, where the board will automatically power on as soon as the Wall or USB connector are plugged in.

2.3 Minicard Types

Lochnagar 2 works with interchangable minicards to allow for a variety of Smart Codec devices. The minicard connectors are fully backwards compatible with the original Lochnagar board.

Minicards should not be inserted or removed while the Lochnagar 2 board is powered. If using the Wall Socket or Battery / Bench Screw Terminals for board power, then it is recommended to fully disconnect or power down the external supply before changing minicards.

There are three main categories of minicard that can connect to Lochnagar 2.
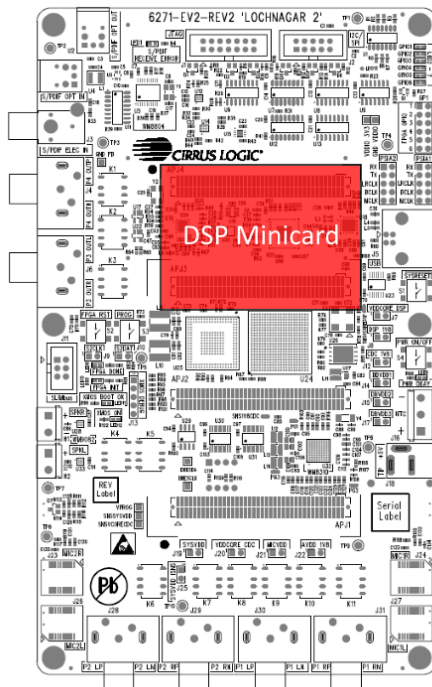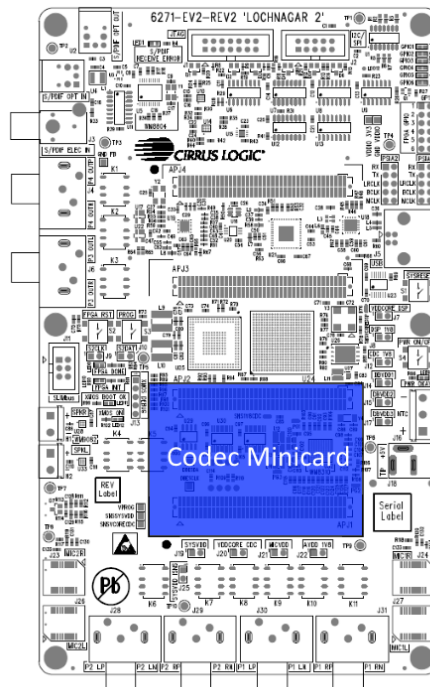
| DSP minicard | Codec minicard (2-header) | Codec minicard (3-header) |
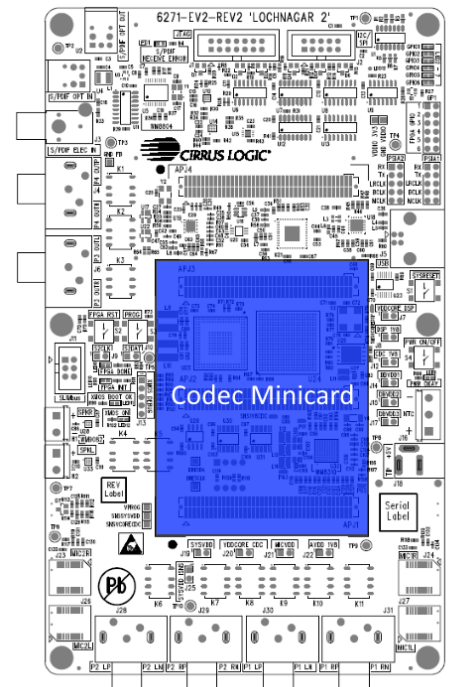
2.3.1 DSP Minicard

This type of minicard was designed for an older range of sidecar DSPs that sit alongside a Codec minicard.

DSP minicards connect to the top two headers on the Lochnagar 2 board.
There are no current product lines that use the DSP minicard slot.

2.3.2 Codec Minicard

Codec minicards house Cirrus Codec and Smart Codec type devices. Smart Codecs include a built-in DSP, but are not classed as "DSP" minicards.

Traditionally Codec minicards connect to the lower two headers on the Lochnagar 2 board.
However, some of the larger Smart Codec devices extend onto the third header in order to make use of the extra I/O.
These cards cannot be used alongside a DSP minicard.

2.3.3 Microphone Minicards

There are four microphone slots on the bottom of the Lochnagar 2 board.
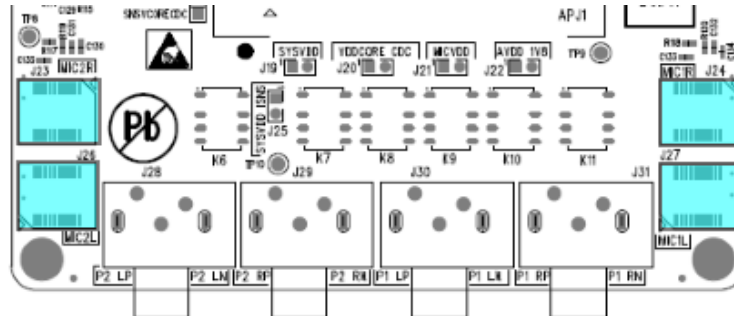
These are designed to accept Cirrus Digital and Analogue microphone minicards.

2.4 Expansion Headers

There are three Expansion Headers on the underside of Lochnagar 2.
These are designed to connect the board to other test hardware. They are commonly used to connect Lochnagar 2 to a Linux Application Processor system.

Expansion Headers
(underside)
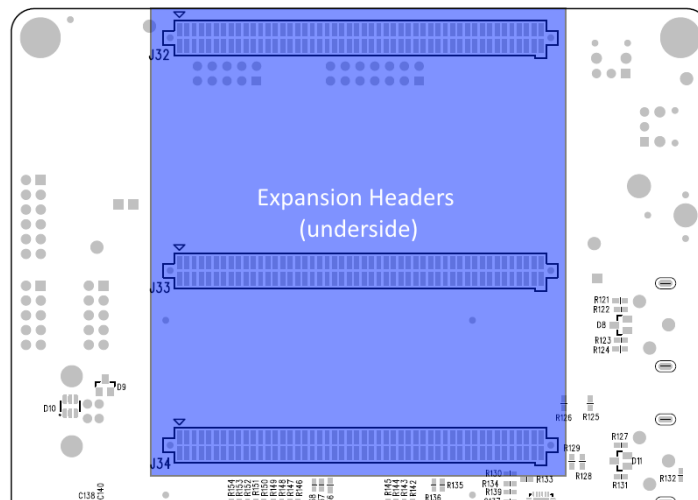
2.5 Buttons / Switches

There are four push buttons on the Lochnagar 2 board connected with power and reset functionality.

Part Number	Name	Description
S1	SYSRESET	Resets all power rails on the board, returning all components to default state inc. Codec and FPGA
S2	FPGA RST	Resets all FPGA registers
S3	PROG	Resets FPGA operation, forcing a reprogram from EEPROM This will also reset all FPGA registers and re-initialise other components on the board
S4	PWR ON/OFF	Press when powered off: Power on the board Hold down for 2 seconds: Power off the board

2.6 LED indicators

There are six status LEDs on Lochnagar that indicate the board's current state of operation

Part Number	Colour	Name	Normally lit?	Description
LED1	Red	S/PDIF RECEIVE ERROR	No	Set to red when there is an error receiving S/PDIF signals
LED2-7	Green	GPIO1 - GPIO6	No	Tied to FPGA GPIOs 1 to 6.
LED8	Green	FPGA DONE	Yes	Indicates that the FPGA booted successfully
LED9	Green	PWR OK	Yes	Indicates the Lochnagar 2 board has power applied
LED10	Red	FPGA INIT	No	Indicates that the FPGA is currently initialising. Should flicker once upon board startup/power applied.
LED11	Green	XMOS BOOT OK	Yes	Indicates that the XMOS USB transceiver chip booted correctly
LED12	Green	XMOS ON	Yes	Indicates that the XMOS USB transceiver chip is powered

2.7 Other Headers

There are several other headers on the Lochnagar 2 board that allow for connections to other systems.
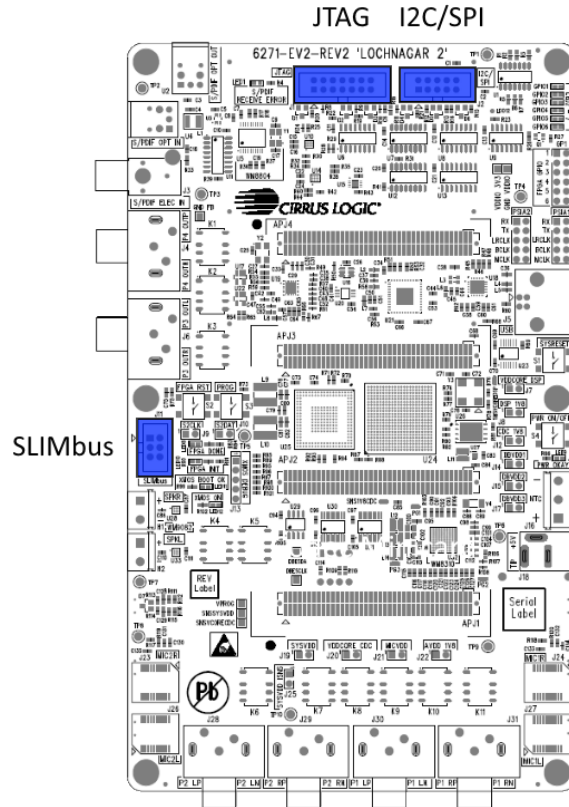
2.7.1 I2C/SPI (Aardvark)

Header J2 (I2C/SPI) is designed to connect to Total Phase Aardvark systems for legacy compatibility with the original Lochnagar board.

All I2C/SPI communications for most use cases is now expected to go through the standard USB/XMOS link that also powers the board and provides USB Audio streaming capability. However, the Aardvark can still be used for legacy applications or as a slave to test SPI master peripherals on the minicard.

2.7.2 JTAG

Header J1 (JTAG) is designed to connect to Macraigor usbWiggler JTAG systems for legacy compatibility with the original Lochnagar board.

As with the I2C/SPI communications, JTAG functionality is now possible using the standard USB link that also powers the board and provides USB Audio streaming. It is still possible to use the Macraigor through this header if required. USB is the default option within the register map.

2.7.3 SLIMbus

A 2x3 box header is provided to connect Lochnagar 2 to LnK SLIMbus test systems.

2.8 Jumper Links

Lochnagar 2 has removed most of the jumpers from the original Lochnagar board, and replaced them with relay switches. All analogue audio routing is now controlled via the FPGA register map.

There are 11 jumpers on the Lochnagar 2 board. These are all related to power supply rails.
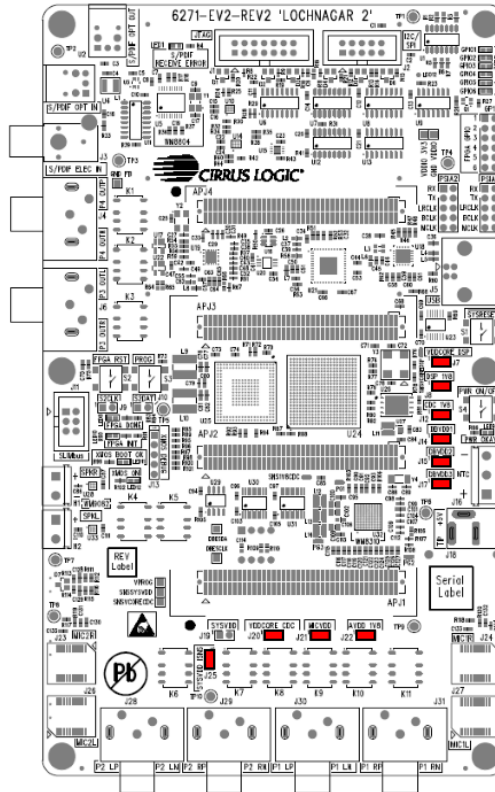
These jumpers allow you to either isolate certain supply rails from the minicard, or insert a series ammeter between the two pins in order to measure current consumption on individual rails.

No jumper should be fitted over J19 (SYSVDD), as this will prevent the built-in current monitor circuitry from working correctly.

Header	Power Rail	Default Voltage	Jumper default
J7	VDDCORE DSP	1.2 V	On (fitted)
J8	DSP 1V8	1.8 V	On (fitted)
J12	CDC 1V8	1.8 V	On (fitted)
J14	DBVDD1	1.8 V	On (fitted)
J15	DBVDD2	1.8 V	On (fitted)
J17	DBVDD3	1.8 V	On (fitted)
J19	SYSVDD	Alternative SYSVDD jumper connection bypassing the current sense circuitry. Should only be used if the current sense circuitry is causing issues.	Off (not fitted)

Header	Power Rail	Default Voltage	Jumper default
J20	VDDCORE CDC	1.2 V	On (fitted)
J21	MICVDD	1.8 V	On (fitted)
J22	AVDD 1V8	1.8 V	On (fitted)
J25	SYSVDD ISNS	Highest of Wall, USB and battery supplies Normally 5V	On (fitted)

Note that these power rail names refer to the rails on the Lochnagar 2 board and may not directly correspond to the rails on the device/minicard. This depends entirely upon the schematic designer of the codec minicard, and how they have decided is the best method to connect the DUT to the Lochnagar system. Always refer to the board schematics if there is any doubt.

(For example, recent codec minicards such as Moon CDB47L91-M-1 do not use the DBVDD1, DBVDD2, DBVDD3, AVDD_1V8 rails, but instead derive all 1.8V rails from the single 1V8_CDC supply rail on Lochnagar and split the rails on the minicard).

3 Driver Installation and WISCE Support

3.1 WISCE™ Device Pack

In order to communicate with the Lochnagar 2 board, WISCE™ needs the Lochnagar 2 Device Pack to be installed.

This automatically installs:

- Latest version of Lochnagar 2 board firmware
  - o Use WISCE plugin to start the update
- Lochnagar 2 configuration plugin for WISCE™
- Current Monitor plugin for WISCE™ to monitor current on selected supply rails
- Lochnagar 2 ASIO drivers for USB audio
- Lochnagar 2 SPI/I2C communications driver
- Register map description for WISCE™
- Sample WISCE™ configuration scripts for the board

If upgrading...

Close all audio streaming applications (eg. Adobe Audition or Foobar) before upgrading your Lochnagar 2 drivers to the latest version.

If an application is streaming audio (or has an open connection to the driver) during the installation process, the driver installation will not be successful. The system will present itself as a "USB Composite Device" and attempts to automatically install the drivers will generate the error "This device cannot start. (Code 10)."

If this happens, the solution is to close all applications and re-install the Device Pack again from scratch.

3.2 Minimum WISCE™ Version

The WISCE™ 3.4.0.3 provides a minimum level of support for Lochnagar 2, but does not provide the full feature set. It is strongly recommended to use version **3.5.0.21** or above.

- The current stable release of WISCE is available from the public Cirrus website
  - o http://www.cirrus.com/en/support/software/evaluationsoftware.html

3.3 Controlling Lochnagar 2

Upon opening WISCE™, the Lochnagar 2 board should be automatically detected.

It will appear as a device called "**LN2 FPGA**" at I2C address 0x44. The **LN2 FPGA** device should have a "Tuning" folder that contains both the **Lochnagar2Plugin** and **Current Monitor** plugin. These allow for full configuration of the Lochnagar 2 board.
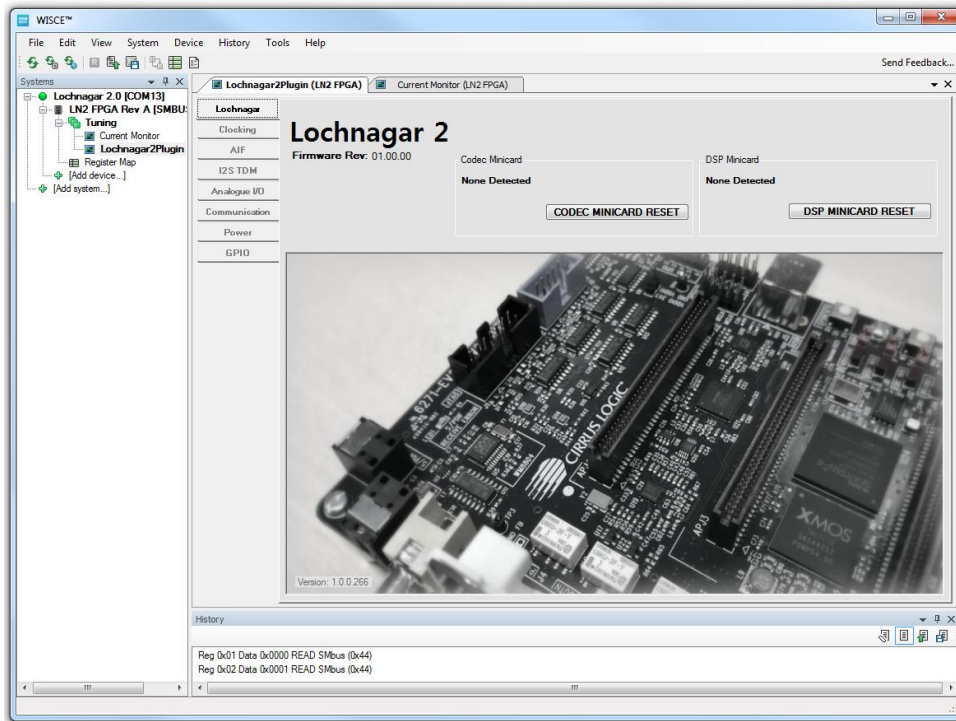
3.4 Lochnagar 2 Firmware Update

After installing the latest WISCE Device Pack, restart WISCE and open the Lochnagar 2 Plugin.

3.4.1 Hardware setup during update

Firmware updates will generally work with most hardware minicards attached.

It is recommended to unplug any minicards, interposers or connectors that have their own separate power supplies during the Lochnagar 2 firmware upgrade process, as they may interfere with the process.

This includes:

- FPGA Emulation Interposers
- Zynq systems
- Amplifier minicards with separate power connections

3.4.2 Optional Update

If the Lochnagar 2 firmware is not up-to-date, a yellow box prompting the user to update the board firmware will be displayed on the main page of the plugin:

3.4.3 Forced Update

If the version of firmware on the board is so old that the plugin / register map will not function at all, the plugin will remove the element of choice and will force the user to do an update before it can operate:

Firmware numbers in the screenshots are for illustration purposes only and may not reflect the behaviour of actual firmware releases.

3.4.4 Updating the Firmware

After clicking the "Update" button in the plugin, it will display a prompt to reset the board and confirm that the user intends to do a board update.
After confirming, it will take 2-3 minutes for the firmware update to complete.
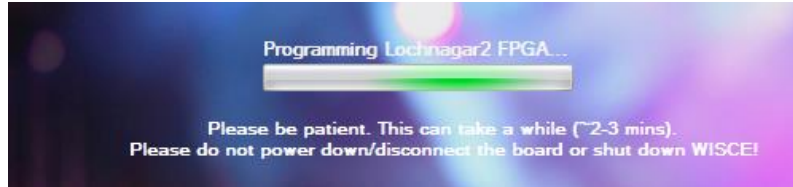
It is important not to shut down WISCE™ or power down or disconnect the Lochnagar 2 board during the firmware update process, as this may result in the Lochnagar 2 hardware becoming unusable.

4   Clocking

The Lochnagar 2 FPGA controls the clock routing on the board.

> If no clock input is provided to the Cirrus device on the minicard, then it may not operate correctly. It is vital to configure the clocks on the Lochnagar 2 board before attempting to use the device.

4.1   Configuring Clock Routing

Digital clock signals on Lochnagar 2 are routed through the central FPGA and can connect the clock signals on the board to a number of input sources.

Routing is controlled via the **Clocking** panel of the Lochnagar 2 plugin.
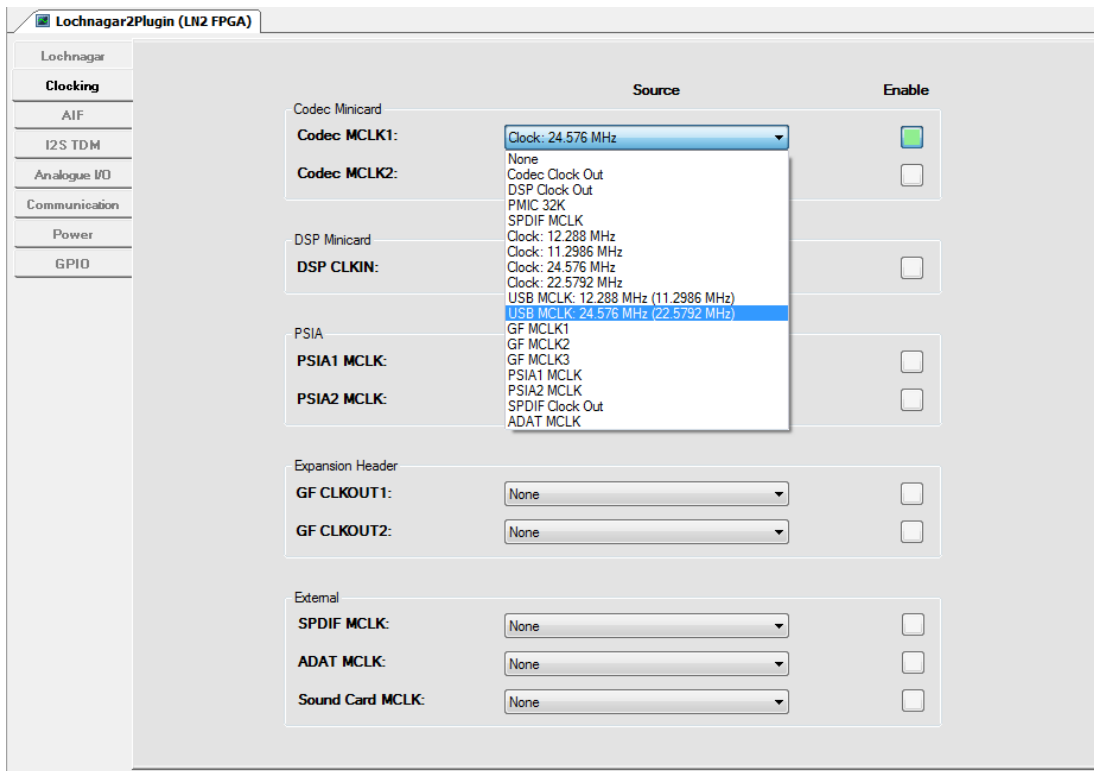
4.2   Clock Setup Guide

The Lochnagar 2 FPGA manages the clocking setup of various clocks on the board.

Clock signals are separated into clock sources (available clock frequencies from a variety of sources) and clock sinks (signals that require an input clock). The Lochnagar 2 allows the user to connect any clock source to any of the available clock sinks. There are some clocks that can be either source or sink, depending on the configuration. For example, if a PSIA header is used to connect the Lochnagar 2 to an Audio Precision test system, the Audio Precision can act as either

MCLK master or slave, depending on the setup. Accordingly, Lochnagar 2 allows this clock signal to be used as either a Sink or a Source.

Lochnagar 2 has an on-board clock generator that generates the following frequencies: 11.2986 MHz, 12.288 MHz, 22.5792 MHz and 24.576 MHz. In addition, clocks can be provided from the USB streaming peripheral, PSIA headers, GF Expansion Headers, PMIC chip, clock output pins from the codec or DSP minicards, the S/PDIF transceiver or ADAT source.

When using digital audio with Cirrus Smart Codec devices, the MCLK signal provided to the chip should be synchronous with any digital audio interfaces used on the chip. For example, if using the audio from the USB audio streaming, the MCLK provided to the slave device needs to be synchronous with the audio data coming from the USB audio streamer. For this reason, a USB, PSIA, S/PDIF and ADAT MCLK signals are provided as available clock sources in the Clocking tab.

4.2.1 Example Configuration

To connect the USB MCLK signal to the Sound Card clock:

1. Open the Clocking tab of the plugin
2. Find the row associated with the Sound Card MCLK clock sink
3. Select USB MCLK: 24.576 MHZ (12.288 MHz) Clock Source from the drop-down menu on the Sound Card MCLK row.
4. Click the enable button on the same row

This will provide the 24/22 MHz USB MCLK signal into the Sound Card peripheral.

4.3 Descriptions of clock sinks and sources

4.3.1 List of Clock Sinks

This lists all the potential destinations that clock signals can be routed to on Lochnagar 2. The register map addresses for the control registers associated with these clock sinks are provided for advanced users.

Clock Sink	Control Register	Description
Codec MCLK1	R1Eh	Master clock input on the codec minicard
Codec MCLK2	R1Fh	Master clock input on the codec minicard
DSP CLKIN	R20h	Clock input on the DSP minicard
PSIA1 MCLK	R21h	Master clock input or output signal on the PSIA1 pin headers
PSIA2 MCLK	R22h	Master clock input or output signal on the PSIA2 pin headers
GF CLKOUT1	R24h	Clock output to the GF expansion headers
GF CLKOUT2	R25h	Clock output to the GF expansion headers
SPDIF MCLK	R23h	Master clock input or output signal for the S/PDIF interface
ADAT MCLK	R26h	Master clock input or output signal for the ADAT interface
Sound Card MCLK	R27h	Clock input signal to the Sound Card hardware on underside of Lochnagar 2

4.3.2 List of Clock Sources

This lists all the potential sources of clock signals that can be routed to the clock sinks listed in the table above. The binary values for these sources are provided for advanced users.

Clock Source	Binary Value	Description
None	0x00	No clock source selected
Codec Clock Out	0x01	Clock output signal generated by the codec
DSP Clock Out	0x02	Clock output signal generated on the DSP minicard
PMIC 32K	0x03	32.578 kHz clock generated by the onboard power management IC
SPDIF MCLK	0x04	Use this clock input for S/PDIF audio use cases Clock output from the S/PDIF receiver chip. Frequency will depend upon sampling rate of SP/DIF audio. With no S/PDIF signal applied, the chip generates a default of 12.0 MHz
Clock: 12.288 MHz	0x05	Fixed 12.288 MHz (48k multiple) clock from onboard clock generator chip.
Clock: 11.2986 MHz	0x06	Fixed 11.2986 MHz (44.1k multiple) clock from onboard clock generator chip.
Clock: 24.576 MHz	0x07	Fixed 24.576 MHz (48k multiple) clock from onboard clock generator chip.
Clock: 22.5792 MHz	0x08	Fixed 22.5792 MHz (44.1k multiple) clock from onboard clock generator chip.
USB MCLK: 12.288 MHz (11.2986 MHz)	0x0A	Use this clock input for USB streaming use cases Half rate clock that is synchronous to USB audio data. Frequency will depend on the sampling rate of audio being transferred over USB This will be either 12.288 MHz or 11.2986 MHz
USB MCLK: 24.576 MHz (22.5792 MHz)	0x12	Use this clock input for USB streaming use cases Full rate clock that is synchronous to USB audio data. Frequency will depend on the sampling rate of audio being transferred over USB This will be either 24.576 MHz or 22.5792 MHz
GF MCLK1	0x0B	Clock signal from the expansion headers on underside. Usually used when connected to Linux Application Processor systems
GF MCLK2	0x0D	Clock signal from the expansion headers on underside. Usually used when connected to Linux Application Processor systems
GF MCLK3	0x0C	Clock signal from the expansion headers on underside. Usually used when connected to Linux Application Processor systems
PSIA1 MCLK	0x0E	Clock signal applied to PSIA1 headers (3.3V I2S pin headers)
PSIA2 MCLK	0x0F	Clock signal applied to PSIA2 headers (3.3V I2S pin headers)
SPDIF Clockout	0x10	Seconary clock output signal from the S/PDIF receiver chip. For advanced use cases only.
ADAT MCLK	0x11	Clock signal from the ADAT receiver when used in ADAT mode.

5 Digital Audio

This section details the digital audio inputs and outputs on the Lochnagar 2 board, and how to configure the routing. Any digital audio interface (AIF) on the Lochnagar 2 system can be connected to any other via the flexible routing of the FPGA.

5.1 Digital Audio Connection Diagrams
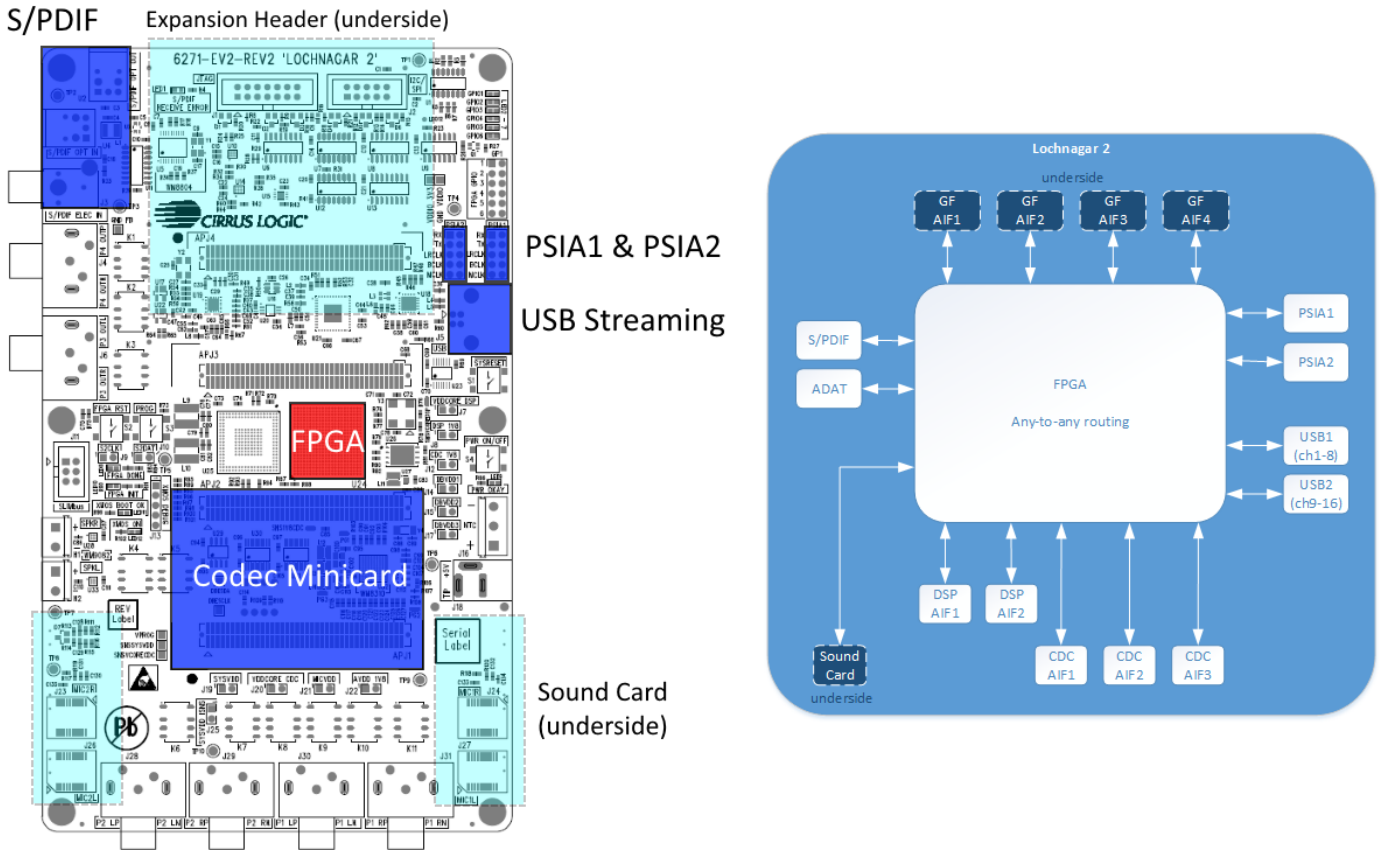
5.2   Configuring Digital Audio Routing

Digital audio signals on Lochnagar 2 are routed through the central FPGA and can connect any AIF port to any other AIF port on the board.

Routing is controlled via the **AIF** panel of the Lochnagar 2 plugin.
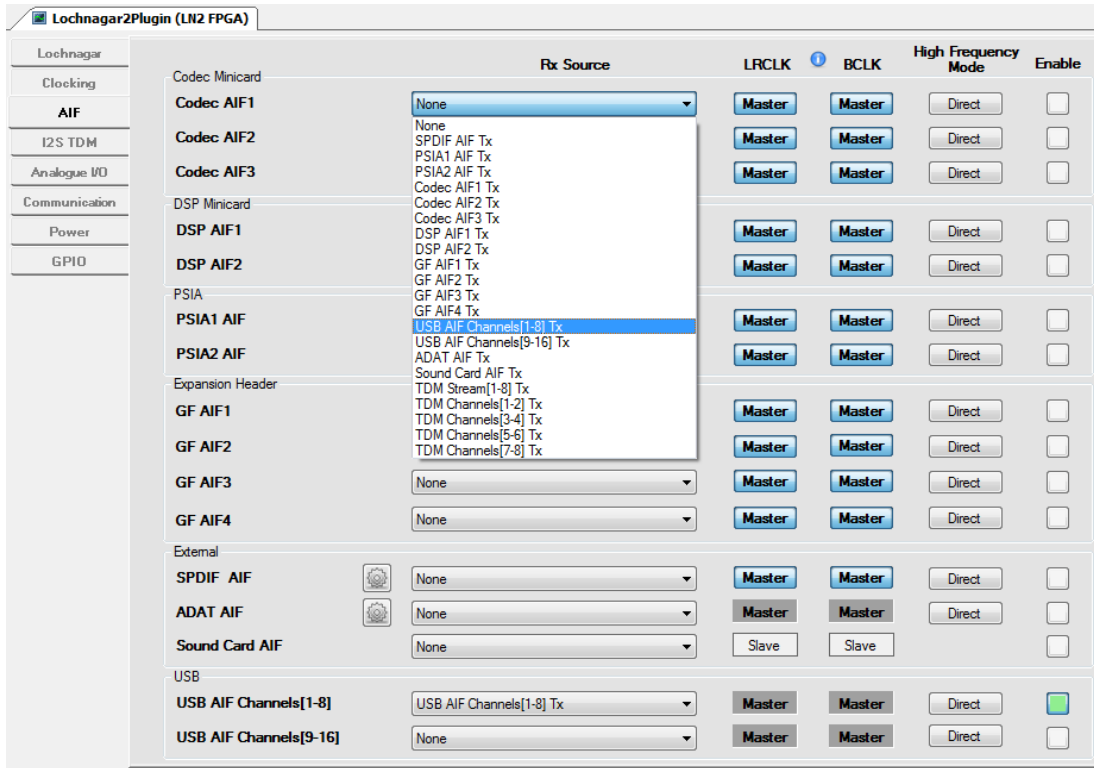
5.2.1   BCLK / LRCLK Routing Operation

The **Rx Source** drop-down menu selects where the audio data comes from for the AIF sink on that row.

If **BCLK/LRCLK** are set to **Slave**, the Lochnagar 2 Board will supply the clocks from audio interface selected in the **Rx Source** selection.

If **BCLK/LRCLK** are set to **Master**, the Lochnagar 2 will not provide any clocks outputs to the AIF sink. The pins will be put into high-Z mode and used as inputs.

Clocks in Slave Mode

If BCLK and/or LRCLK for an AIF device are set to "Slave" mode, the Rx Source should not be set to "None", as this will mean that no clocks are provided to the AIF Slave device.

5.2.2   High Frequency Mode

Path delays in AIF systems can cause problems when the round trip delay between the AIF master and slave devices is comparable to the period of the BCLK signal. In these scenarios, the return data received by the slave may be corrupted.

Lochnagar 2 provides a buffered "High Frequency Mode" setting that will compensate for long round trip delays by introducing a single audio frame of buffering into the AIF master return data.

Typically, this is required when the BCLK signal is higher than 12.288 MHz (from USB AIF, this will typically be for 96 kHz or 192 kHz sampling rates), but depending on the exact audio routing setup on the Lochnagar 2 board, it may also be required at lower BCLK rates. This is also required to compensate for minicards that have long PCB tracks or cabling between the Lochnagar 2 and the DUT.

The High Frequency Mode setting is only available on AIF peripherals where both BCLK and LRCLK are configured as AIF master.

There are two potential settings:

- Direct Mode = No buffering or delay is added onto this AIF signal by the Lochnagar 2 board
- Buffered Mode = A single audio frame of delay is introduced to the data received by this AIF master from the Rx Source.

Direct Mode is the default setting as it provides the lowest possible latency through the system.
If audio corruption is observed at the AIF master, it is possible to resolve this by enabling the "Buffered" High Frequency Mode setting.

5.2.3   Example Configuration

To set up an AIF connection between the USB audio streaming and Codec AIF1 port:

1. Find the Codec AIF1 row on the **AIF** tab of the Lochnagar 2 plugin.
2. Select a Rx Source for this audio connection. Choose USB AIF Channels[1-8] Tx to connect it to the USB streaming peripheral.
3. Select whether Codec AIF1 is master or slave for the BCLK and LRCLK. Since USB streaming operates as master only, they must both be set to Slave in this example.
4. If audio is required in both directions, find the row for USB AIF Channels[1-8], and set the Rx Source to Codec AIF1 Tx. This will make the audio bidirectional.
5. If required, select the Buffered High Frequency Mode on the USB AIF Channels[1-8] row to add optional buffering into the return path. This may be required if the return data from the codec is corrupted due to path length delays.
6. Enable both interfaces using the buttons on the right of each row.

It is also important to make sure that the codec has an MCLK that is connected to a synchronous clock source.
In this scenario, the **Clocking** panel of the plugin should be used to set MCLK1 or MCLK2 to the USB MCLK.

5.2.4   Advanced Clocking Configurations

Audio paths do not need to be set up directly between two AIF interfaces, and BCLK/LRCLK do not necessarily have to be driven by the same master or in the same direction, assuming that the Slave device also supports that mode. A single AIF master could potentially clock multiple slave devices by daisy-chaining the audio from one slave AIF port to the next.

This flexibility means that the Lochnagar 2 can be set up to emulate almost any potential AIF configuration in order to develop solutions or replicate problems.

Note that there is no protection for scenarios where the FPGA is configured incorrectly, so it is also important to make sure that the AIF interface connected to the FPGA is configured in the appropriate manner. If Codec AIF1 is set up as a Master on the DUT and also in the FPGA, the two devices will drive against each other on the line and potentially create mid-rail voltages.

5.3 AIF interfaces on codec minicard

The codec minicard supports up to three AIF interfaces (for smaller cards with two connectors) or five AIF interfaces (for larger cards that span over three connectors).

5.4 AIF interfaces on the expansion headers

The expansion headers on the underside of Lochnagar 2 are designed to connect Lochnagar 2 to Linux Application Processor systems. The headers on the underside support up to four AIF interfaces.

5.5 PSIA Headers

These headers are designed to connect to Audio Precision testing equipment through the PSIA (Programmable Serial Interface Adapter) hardware.

This is essentially a standard I2S-based digital audio interface with 3.3V signal levels, consisting of the following signals:

The silkscreen markings on Lochnagar 2 will help the user determine which pin is which. Note that TX and RX directions are with respect to the external PSIA hardware, therefore the pin marked "RX" is an output from the FPGA.
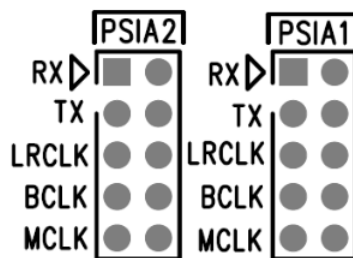
- RXDAT (pin 1)
- TXDAT (pin 3)
- LRCLK (pin 5)
- BCLK (pin 7)
- MCLK (pin 9)
- Ground signals (pins 2, 4, 6, 8, 10)

Clocking

When using the PSIA with a Cirrus codec device, the codec can be used as either AIF clock master or clock slave.
The **Clocking** panel of the Lochnagar 2 Plugin should be used to configure the MCLKs of the codec and PSIA ports appropriately.

5.6 S/PDIF and ADAT

There are S/PDIF optical and electrical input connectors on Lochnagar 2, and a single S/PDIF optical output connector. Lochnagar 2 also supports using ADAT protocol with the optical connectors.

ADAT

Lochnagar 2 only supports ADAT protocol with 48 kHz sampling rate, and it can only be used in I2S clock master mode.

5.6.1 Standard use cases

S/PDIF can be used with either electrical or optical input connector.
ADAT can only be used with the optical input. If the optical input is already being used for S/PDIF, it cannot be used for ADAT.

There is only a single optical output, and can be used with either the S/PDIF or ADAT output.
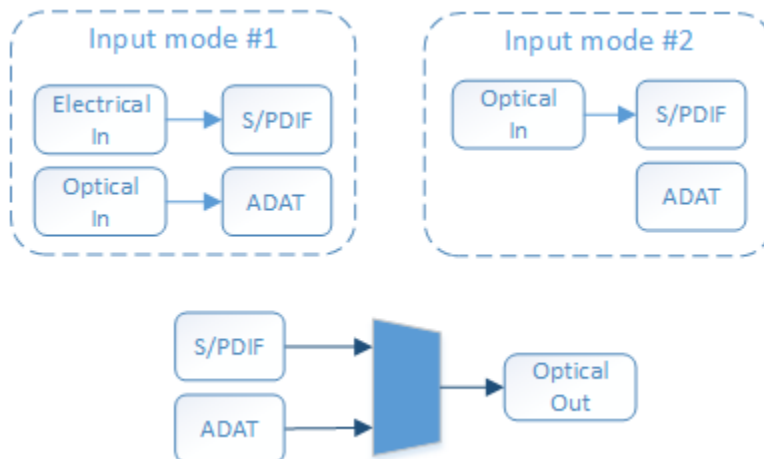
These configuration options can be selected within the **AIF** panel of the Lochnagar 2 Plugin.

Click the cogwheel-shaped "setup" icon next to either "SPDIF AIF Rx" or "ADAT AIF Rx".
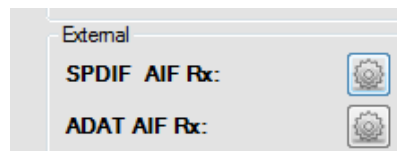
This will bring up the S/PDIF and ADAT configuration options.
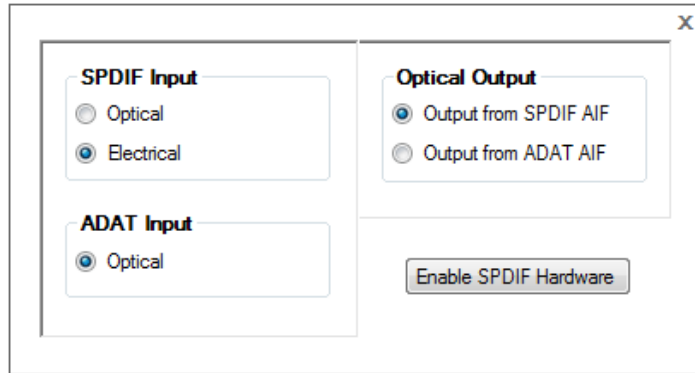
If using S/PDIF, it is important to click the "Enable SPDIF Hardware" button on this panel to bring the WM8804 S/PDIF transceiver chip out of reset.

Clocking

When using S/PDIF or ADAT audio as clock masters with a Cirrus codec device in slave mode, it is important that one of the codec's MCLK pins is connected to a clock source that is synchronous to the audio coming from the S/PDIF or ADAT source.
The **Clocking** panel of the Lochnagar 2 Plugin should be used to assign either MCLK1 or MCLK2 to one of the SPDIF MCLK or ADAT MCLK sources as appropriate.

5.6.2   Advanced use cases

Lochnagar 2 also supports more advanced use case configurations using the WM8804 S/PDIF transceiver chip, including operating in clock slave mode.
Since these require the additional configuration of the WM8804 chip, these modes cannot be enabled through the Lochnagar 2 plugin and are left for advanced users only.

Firstly, the I2C bridge to the WM8804 chip must be enabled.
This will connect the primary I2C bus on the system (I2C1) to the SPDIF I2C bus (SPDIF_I2C)

SPDIF_I2C_BRIDGE1_ENA	I2C4_BRIDGE1_ENA	I2C3_BRIDGE1_ENA	I2C2_BRIDGE1_ENA	I2C1_BRIDGE1_ENA
1	0	0	0	1

The WM8804 should be placed into Software Control mode (SPDIF_HWMODE = 0) and then taken out of reset (SPDIF_RESET_N = 1):

SPDIF_HWMODE	SPDIF_IN_SEL	SPDIF_TX_SEL	SPDIF_RESET_N
0	1	0	1

The WM8804 control interface can now be accessed over I2C and configured into a custom mode.

5.7 Sound Card

There are 3 x stereo input 3.5 mm jacks and 3 x stereo output 3.5 mm jacks on the underside of Lochnagar 2. These comprise the "Sound Card".

These inputs and outputs are not connected directly to analogue ports on the minicard, but are presented as digital audio I/O within the **AIF** audio routing panel of the Lochnagar 2 Plugin. Audio from any AIF port on the Lochnagar can be routed directly to the Sound Card.
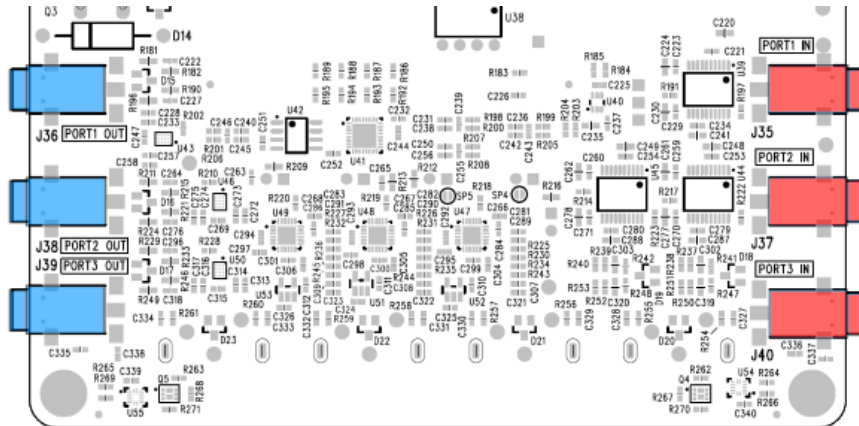
Underside of Lochnagar 2. Output ports in blue, input ports in red.

5.7.1 Sound Card Audio Format

- The Sound Card expects to receive a 4 or 8 channel TDM I2S signal.
- The Sound Card will always be the BCLK/LRCLK slave
- The Sound Card must be provided with a synchronous MCLK in the **Clocking** panel of the Lochnagar 2 Plugin.

The TDM channels in the I2S stream will map directly to the 3.5 mm jacks as shown below.

PORT1 left	1
PORT1 right	2
PORT2 left	3
PORT2 right	4
PORT3 left	5
PORT3 right	6

This channel mapping applies to both input and output ports.

5.7.2 Enabling the Sound Card

The Sound Card is enabled within WISCE by doing the following:

1. Set up a clock source for the Sound Card MCLK on the Clocking panel and enable it
2. Set up the Sound Card as a source or sink within the AIF routing panel
3. Click the enable button on the Sound Card row

Clocking

The Sound Card always operates in clock slave mode. An Rx Source must be selected in order to supply BCLK and LRCLK signals.

In addition, the **Clocking** panel of the Lochnagar 2 Plugin should be used to assign an appropriate clock source to the Sound Card MCLK input. Without a synchronous MCLK input, the Sound Card will not function correctly.

5.8 Descriptions of AIF sinks and sources

5.8.1 List of AIF Sinks

This lists all the potential destinations that digital audio signals can be routed to on Lochnagar 2. The register map addresses for the control registers associated with these AIF sinks are provided for advanced users.

Category	Name	Control Register	Description
Codec Minicard	Codec AIF1	R0Dh	AIF1 port on the codec minicard
Codec Minicard	Codec AIF2	R0Eh	AIF2 port on the codec minicard
Codec Minicard	Codec AIF3	R0Fh	AIF3 port on the codec minicard
DSP / Codec Minicard	DSP AIF1 / Codec AIF4	R10h	How this interface is displayed in the plugin will depend upon your minicard May be either AIF4 on codec minicard or AIF1 on DSP minicard (obsolete)
DSP / Codec Minicard	DSP AIF2 / Codec AIF5	R11h	How this interface is displayed in the plugin will depend upon your minicard May be either AIF5 on codec minicard or AIF2 on DSP minicard (obsolete)
PSIA	PSIA1 AIF	R12h	PSIA pin headers for connection to Audio Precision PSIA or debug
PSIA	PSIA2 AIF	R13h	PSIA pin headers for connection to Audio Precision PSIA or debug
Expansion Header	GF AIF1	R16h	Expansion header on underside of Lochnagar 2
Expansion Header	GF AIF2	R17h	Expansion header on underside of Lochnagar 2
Expansion Header	GF AIF3	R14h	Expansion header on underside of Lochnagar 2
Expansion Header	GF AIF4	R15h	Expansion header on underside of Lochnagar 2
External	SPDIF AIF	R18h	S/PDIF optical input/output *Note: Basic use case is clock master only. If S/PDIF is used in clock slave mode, it will require extra configuration on the WM8804 S/PDIF transceiver chip to operate correctly. Note: S/PDIF requires extra configuration before it will operate. Click on the cogwheel 'setup' icon to select ADAT / S/PDIF options.*
External	ADAT AIF	R1Bh	ADAT optical input/output *Note: ADAT can be used in clock master mode only. If ADAT is in use, then S/PDIF will be limited to electrical input only. Note: ADAT requires extra configuration before it will operate. Click on the cogwheel 'setup' icon to select ADAT / SP/DIF options.*
External	Sound Card AIF	R180h	Analogue audio inputs and outputs through the 3.5 mm jacks on underside of the board. A clock supply must also be provided to the Sound Card before it will operate.
USB	USB AIF Channels[1-8]	R19h	USB audio streaming ASIO channels 1-8 *Note: USB streaming can only function in clock master mode*
USB	USB AIF Channels[9-16]	R1Ah	USB audio streaming ASIO channels 9-16 *Note: USB streaming can only function in clock master mode*

5.8.2 List of AIF Sources

This lists all the potential sources of digital audio data that can be routed to the AIF sinks listed in the table above. The binary values for these sources are provided for advanced users.

Category	Name	Binary Value	Description
	None	0x00	No audio source connected to this sink
External	SPDIF AIF Tx	0x01	S/PDIF optical or electrical input
PSIA	PSIA1 AIF Tx	0x02	PSIA pin headers for connection to Audio Precision PSIA or debug
PSIA	PSIA2 AIF Tx	0x03	PSIA pin headers for connection to Audio Precision PSIA or debug
Audio Card	Codec AIF1 Tx	0x04	AIF1 port on the codec minicard
Audio Card	Codec AIF2 Tx	0x05	AIF2 port on the codec minicard
Audio Card	Codec AIF3 Tx	0x06	AIF3 port on the codec minicard
DSP Card / Audio Card	DSP AIF1 Tx / Codec AIF4 Tx	0x07	How this interface is displayed in the plugin will depend upon your minicard May be either AIF4 on codec minicard or AIF1 on DSP minicard (obsolete)
DSP Card / Audio Card	DSP AIF2 Tx / Codec AIF5 Tx	0x08	How this interface is displayed in the plugin will depend upon your minicard May be either AIF5 on codec minicard or AIF2 on DSP minicard (obsolete)
Expansion Header	GF AIF1 Tx	0x0B	Expansion header on underside of Lochnagar 2
Expansion Header	GF AIF2 Tx	0x0C	Expansion header on underside of Lochnagar 2
Expansion Header	GF AIF3 Tx	0x09	Expansion header on underside of Lochnagar 2
Expansion Header	GF AIF4 Tx	0x0A	Expansion header on underside of Lochnagar 2
USB	USB AIF Channels[1-8] Tx	0x0D	USB audio streaming input (from PC) ASIO channels 1-8 *Note: USB streaming can only function as clock master*
USB	USB AIF Channels[9-16] Tx	0x0E	USB audio streaming input (from PC) ASIO channels 9-16 *Note: USB streaming can only function as clock master*
External	ADAT AIF Tx	0x0F	ADAT optical input. *Note: the ADAT hardware will need additional configuration* *Click the cogwheel Setup icon to complete ADAT setup*
External	Sound Card AIF Tx	0x10	Analogue inputs from the 3.5 mm jacks on the underside of Lochnagar 2 *Note: an MCLK for the Sound Card must be configured in the clocking panel* For more details, see: Sound Card
I2S TDM Converter	TDM Stream[1-8] Tx	0x11	8 channel I2S stream from the I2S TDM Converter block *Note: See I2S TDM panel to complete the setup*
I2S TDM Converter	TDM Channels[1-2] Tx	0x12	De-muxed channels 1-2 from the 8-channel TDM to stereo conversion in the I2S TDM Converter block *Note: See I2S TDM panel to complete the setup*
I2S TDM Converter	TDM Channels[3-4] Tx	0x13	De-muxed channels 3-4 from the 8-channel TDM to stereo conversion in the I2S TDM Converter block *Note: See I2S TDM panel to complete the setup*
I2S TDM Converter	TDM Channels[5-6] Tx	0x14	De-muxed channels 5-6 from the 8-channel TDM to stereo conversion in the I2S TDM Converter block *Note: See I2S TDM panel to complete the setup*
I2S TDM Converter	TDM Channels[7-8] Tx	0x15	De-muxed channels 7-8 from the 8-channel TDM to stereo conversion in the I2S TDM Converter block *Note: See I2S TDM panel to complete the setup*

6 USB Audio Streaming

The Lochnagar 2 board presents itself as a USB audio device to the host PC using USB Audio Class 2 to transfer audio data.

Do not reset or power down when streaming USB audio

If the Lochnagar 2 board is streaming USB Audio 2.0 when it is reset, the Windows audio drivers will stall. This is a common issue with Windows audio drivers when using external USB sound cards. When Lochnagar 2 is reconnected to the system, it may then fail to connect to WISCE due to the audio driver issues. In order to reconnect, the application playing USB audio to the Lochnagar 2 board must be stopped. If a failed attempt at connecting to WISCE has already occurred, the Lochnagar 2 board may need another reset in order to re-establish communications with the system.

6.1 CLUSBAudio Control Panel

This is a control panel for the Lochnagar 2 XMOS USB audio streaming system. A link to open the CLUSBAudio Control Panel can be found in the "Cirrus Logic" folder in the Start Menu.
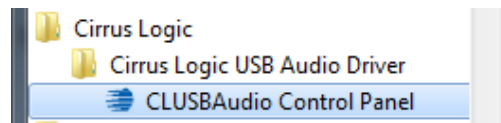
The main Status tab of the CLUSBAudio Control Panel will display the Current Sampling Rate being used by Lochnagar 2. This will be determined by either the Windows drivers setting (for DirectSound) or the audio software (for example Adobe Audition) for ASIO or WASAPI. This is useful for confirmation that audio is playing at the correct sampling rate.
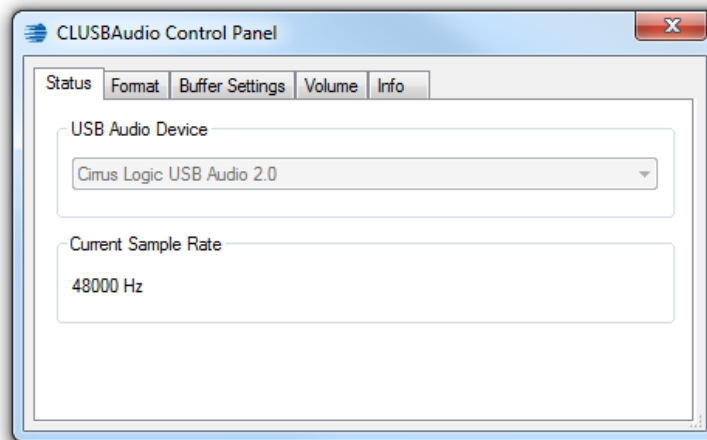
The Format tab may be required for use cases where the sampling rate is 192 kHz. Due to limitations in bandwidth, Lochnagar 2 cannot support a full 16 channels of 24-bit audio at 192 kHz, so a choice must be made by the user to either reduce the bit depth to 16 bits, or channel count to 8 channels.

On this tab, 'Input' refers to audio coming from Lochnagar 2 into the PC, and 'Output' refers to audio being transferred from the PC to Lochnagar 2.
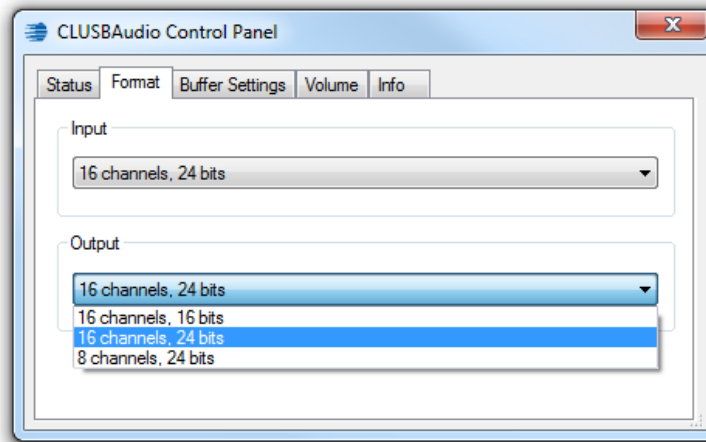
For all other sampling rates:

- 16 channels, 24 bits (**default recommended option**)

For 192 kHz:

- 8 channels, 24 bits

The format of the Input channels should match that of the Output channels.

For all use cases other than 192 kHz sampling rates, it is recommended to keep these settings at the default value of 16 channels at 24 bits. Note that the input and output format selection made here will apply to the XMOS audio streaming device regardless of the audio drivers used (ASIO, WASAPI, DirectSound) so it is important to make sure this selection is correct if 192 kHz audio is to be played.

192 kHz Mode

For 192 kHz mode, only the 8 channels / 24 bit mode will operate correctly. Other modes will create bit-shifts (and therefore audible distortion) when WISCE™ is used at the same time as audio streaming. Both Input and Output settings must be set to 8ch/24-bit mode in the CLUSBAudio Control panel. This is true regardless of whether you are using Windows DirectSound, WASAPI or ASIO drivers to get the 192 kHz output audio.

The Buffer Settings tab should be set to the following values:

- USB Streaming Mode = Standard
- ASIO Buffer Size = Auto

These settings can be modified to provide a larger or smaller USB buffer, but be aware that some applications (e.g. Adobe Audition) may have problems with particular combinations of Sample Rate and Buffer Size.
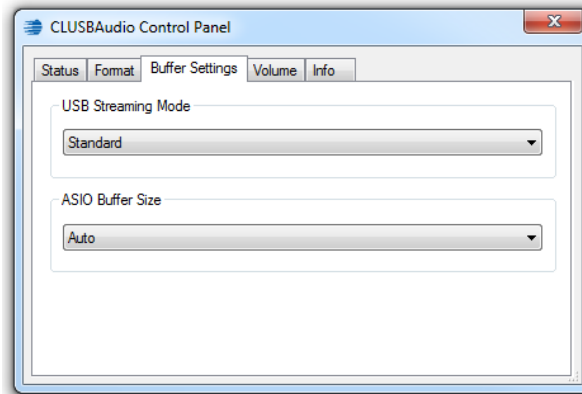
6.2 Using Lochnagar 2 with Windows DirectSound

Lochnagar 2 can act and function as a normal stereo USB audio device on a Windows system using Windows DirectSound drivers. Although Windows Vista introduced native support for WASAPI, which is technically superior, DirectSound is still the default audio driver for all Windows OS versions.

Stereo audio from standard Windows applications (Media Player, iTunes, Spotify, web browsers) can be routed through the Lochnagar 2 by simply selecting it as your default audio device on the system within the Control Panel.
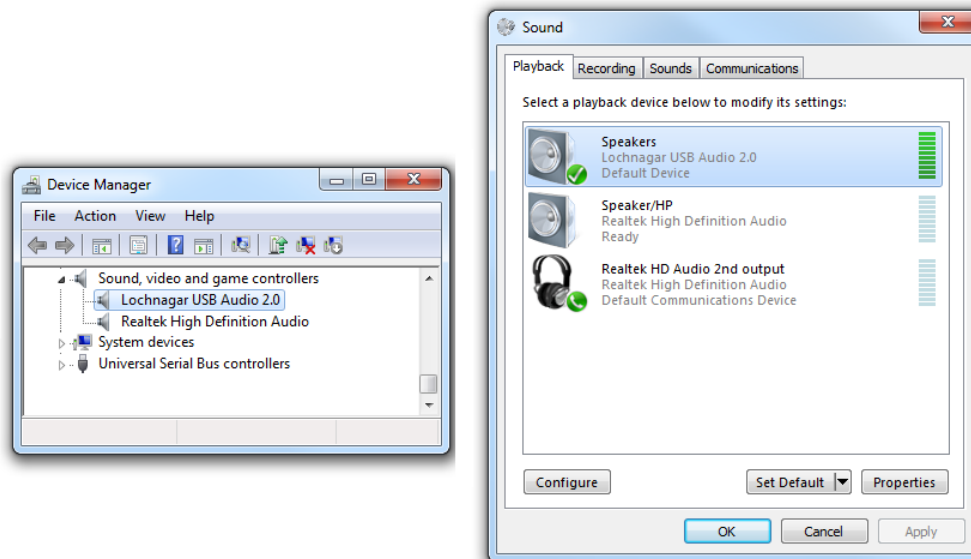
This has some limitations. Firstly, it only supports 2 channels, and all audio will be resampled by Windows to the sampling rate set within the Advanced panels of the "Speakers Properties" display (accessed by right-clicking on

'Speakers/Lochnagar USB Audio 2.0' in the window shown above). The input channels will operate at the rate set within the Advanced panel of the "Line Properties" display.

If the USB audio streaming is used for simultaneous playback and recording, the playback and record sampling rates must be set to the same value.
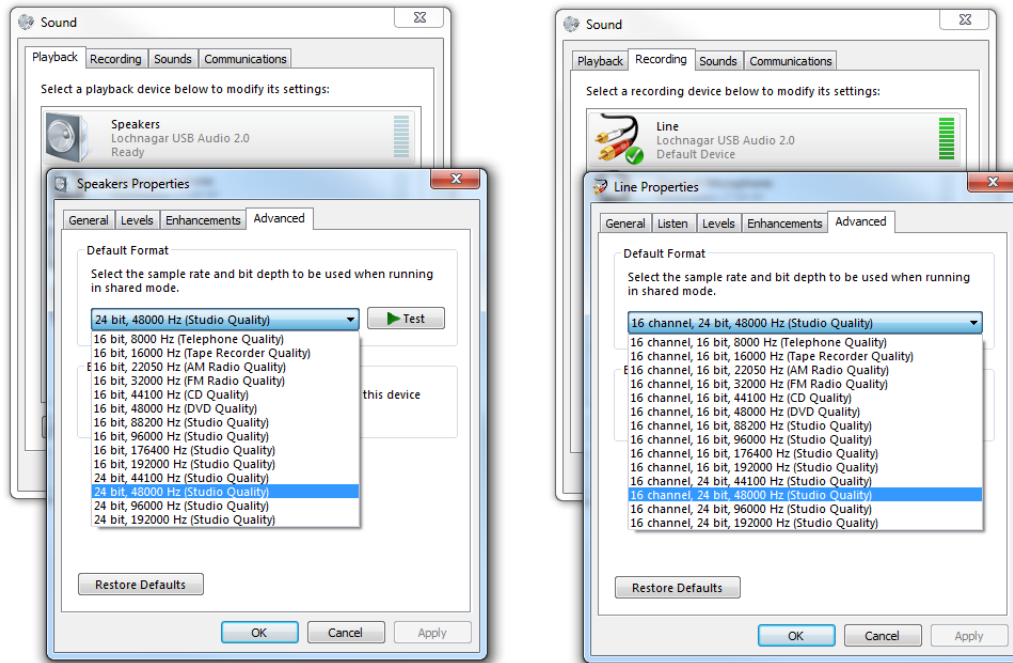
6.3   Using Lochnagar 2 with WASAPI

With Windows Vista, Microsoft introduced the Windows Audio Session Application Programming Interface (WASAPI) audio transport method. This is technically superior to DirectSound and offers lower distortion and options to bypass mixing if used in Exclusive mode, similar to ASIO default functionality. It allows the user to set the audio sampling rate through the application, rather than the Control Panel audio device properties, allowing for easier support for multiple sampling rates.

Note that although WASAPI itself is included with Windows, most standard applications do not use it and even media players such as Foobar require an extra WASAPI plugin to interface with the transport. The WASAPI interface to Lochnagar 2 will appear in the media player's device selection list as "WASAPI: Speakers (Lochnagar USB Audio 2.0)". Lochnagar 2.0 supports both Event and Push modes; Microsoft recommends using Event mode where possible.

While DirectSound may be used for convenience, it is recommended to use ASIO over WASAPI if multichannel or bit-exact audio is required.

6.4 Using Lochnagar 2 with ASIO

ASIO drivers for Windows are installed as part of the Lochnagar 2 Device Pack.

Using ASIO will allow up to 16 channels to be transferred to and from the Lochnagar 2 board and provides higher bandwidth, lower latency, less jitter and un-mixed/un-distorted audio that bypasses the Windows Kernel Mixer. However, this requires specialist audio software such as Adobe Audition to interface with the ASIO drivers, as Windows does not support USB Class 2 Audio natively. This section will detail how to set up Lochnagar 2 on both Adobe Audition and Foobar.

Volume Settings

Due to an issue with the ASIO drivers, the volume control settings within the Windows operating will affect the volume of audio supplied to the Lochnagar 2 board, even when ASIO drivers are in use. If the Windows mixer settings are set to anything other than 100% volume, then the audio from ASIO applications such as Adobe Audition may not be bit-accurate to the original source material.

6.4.1 Adobe Audition Setup

In order to use Lochnagar 2 with ASIO on Windows, an ASIO-compatible sound editor is required. For this example, Adobe Audition is used, but setup on other editors should be very similar.

1. Enter the Audio Hardware panel in the Preferences box.
2. Select "ASIO" as the Device Class
3. Select "Cirrus Logic ASIO Driver" as the Device
4. Tick the "Attempt to force hardware to document sample rate" box, if it is present in your version of Audition
   a. If this option is not available, you will need to use the CLUSBAudio application to set hardware sample rate. This can be accessed via Start Menu or by clicking the "Settings..." button within the Audition Audio Hardware panel.
5. Click "OK" to save changes
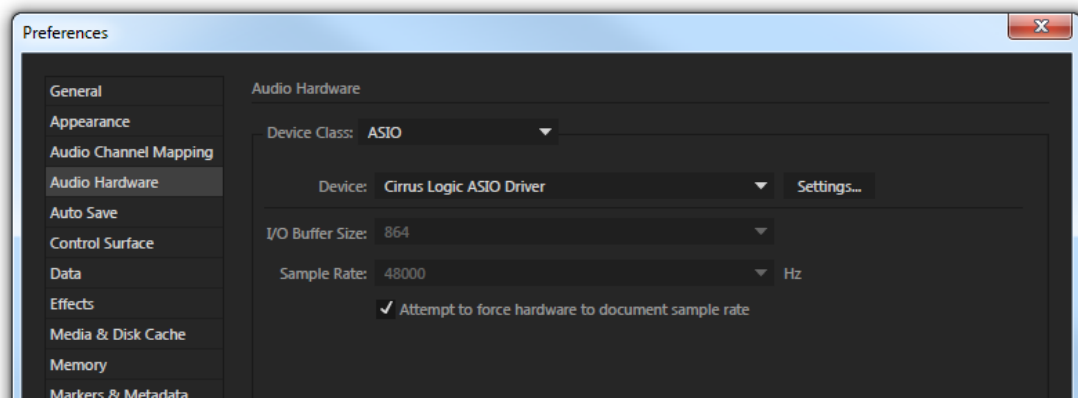
When selecting an output channel for each track in the project, there will now be 16 available input and output channels to select.
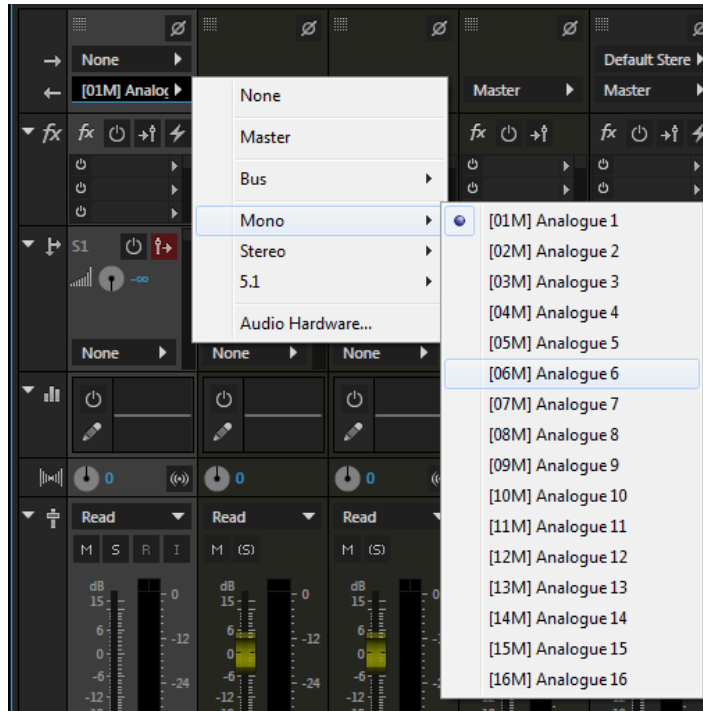
6.4.2 Foobar Setup

Foobar is a free media player which also offers ASIO support, although its multi-channel support is limited. However, it may be preferable in many instances since it is free to download and does not require a license or subscription.

1. Download and install Foobar if required: http://www.foobar2000.org/download
2. Download the and install the ASIO plugin for Foobar: http://www.foobar2000.org/components/view/foo_out_asio
3. Go to File->Preferences->Playback->Output. Select "ASIO: Cirrus Logic ASIO Driver" from the drop-down list of devices. Click "OK" to save preferences.
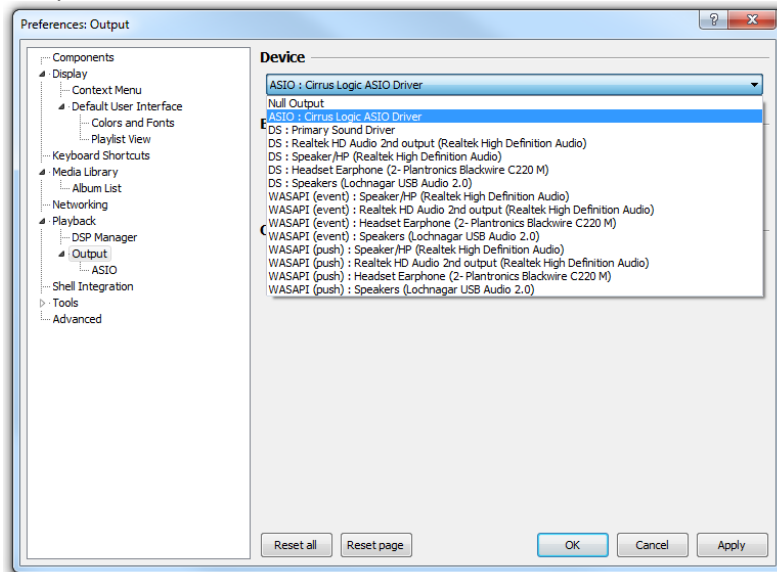
4. The default channel mapping maps the audio's Left channel to ASIO output channel 1, and Right channel to ASIO output channel 2. These mapping can be re-mapped by entering the 'ASIO' sub-panel of the Output preferences and creating a custom channel mapping.
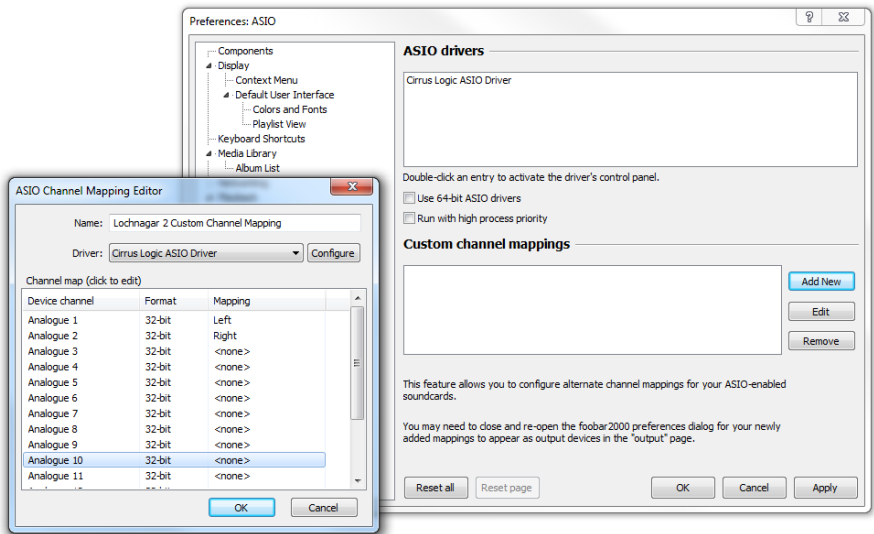
5. Once a custom channel mapping has been created, it can be selected from the drop-down Device select list on the main Output preferences panel.
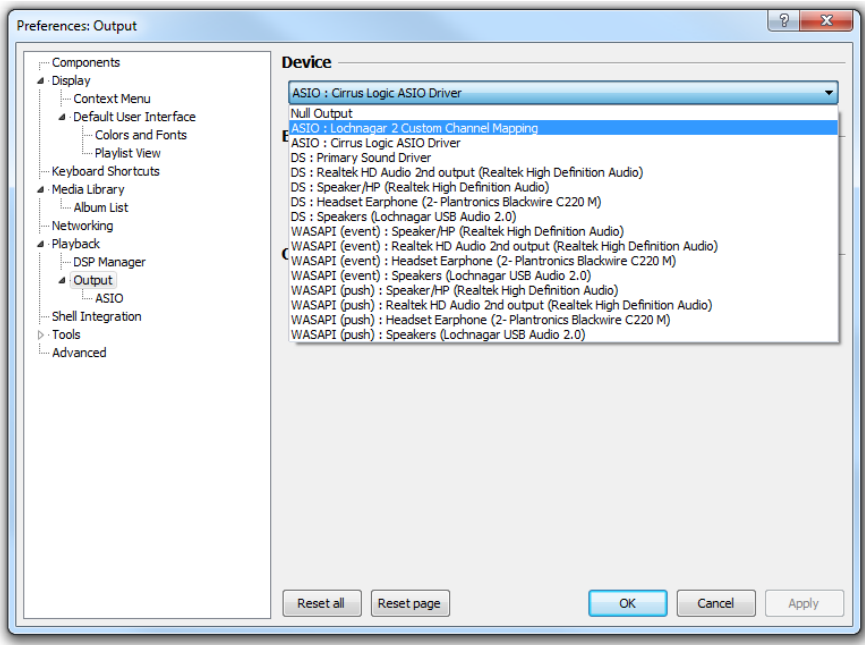
Note that Foobar allows for multichannel ASIO output, but the source file must be encoded as a multi-channel (eg. 5.1) file - it cannot play two stereo files simultaneously to four different ASIO output channels like Adobe Audition can.

6.5 I2S Format on Lochnagar 2

Regardless of which audio driver type is used, the onboard XMOS USB streamer device will convert the 16 channels of audio data from the PC into two data streams, each in 8-channel TDM I2S format. Each set of 8 channels can be routed separately to any AIF interface on the board.

- **USB AIF Channels[1-8]** maps to ASIO channels 1-8
- **USB AIF Channels[9-16]** maps to ASIO channels 9-16

The output format from the XMOS will always be in 8-channel I2S format, even if only 2/4/6 channels are used. The XMOS will always be the master of the BCLK and LRCLK signals, as the sampling rate will be dictated by the PC/ASIO driver. When the XMOS streaming audio is routed to a Cirrus Smart Codec AIF peripheral, the AIF port of the Cirrus device should be configured as a slave expecting data in this format.

Note that when using 192 kHz sampling rate, the user must choose between reducing the total number of channels from 16 to 8 channels, which would mean that only four channels TDM is used; or reducing the sample bit depth to 16 bits. In both scenarios, the number of BCLKs per LRCLK frame will be halved, and this must be reflected in the Cirrus Codec AIF setup.

Stereo data transferred to Lochnagar 2
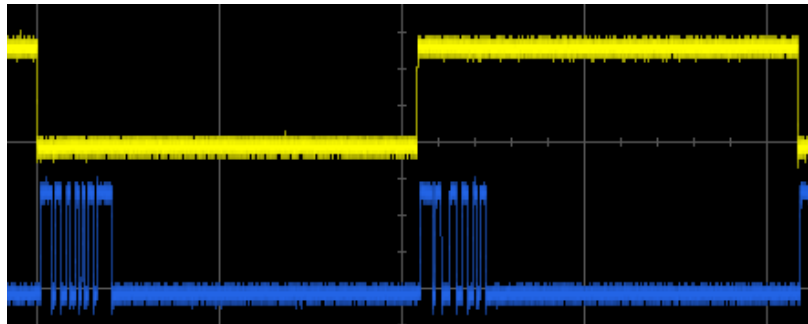
The USB audio output from XMOS will always be in 8 channel TDM I2S format, even when using stereo data audio in DirectSound mode.

8 channel TDM data transferred to Lochnagar 2 via ASIO
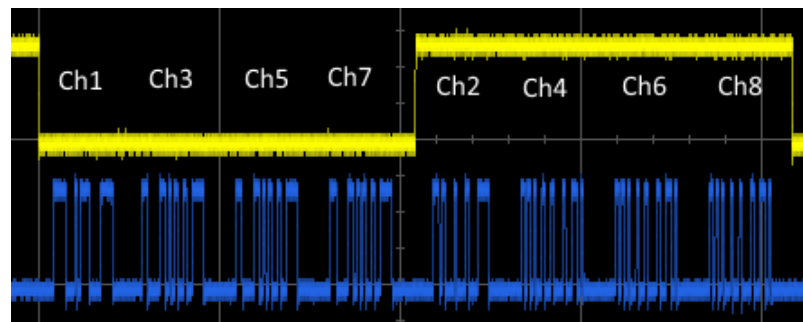
When using the AIF routing option USB AIF Channels[1-8], the channel number shown in the image map directly to the ASIO channel numbers (eg "Analogue 1") as seen in Adobe Audition screenshots above.
When using AIF routing option USB AIF Channels[9-16], the 8 channels of TDM I2S map to ASIO channels 9-16 rather than 1-8.

7   I2S TDM

The Lochnagar 2 FPGA provides a peripheral block that will convert 8-channel TDM I2S data into stereo I2S streams and vice versa.

The Lochnagar 2 USB Audio Streaming peripheral always operates using 8-channel I2S audio data with 32-bit audio slots (or 4-channel at 192 kHz) and in some cases this may be undesirable. For example, running with a faster BCLK than is required will slightly increase the power consumption on the digital buffer voltage supply rail, and for power sensitive applications this may be undesirable. For this purpose, the Lochnagar 2 board can convert 8-channel 256Fs TDM I2S data into four separate streams of stereo 64Fs I2S data that can be routed to four separate destinations on the Lochnagar 2 board. Similarly, the return data from the four separate I2S streams can be combined into a single 8-channel TDM I2S return channel.

7.1   I2S TDM Mux/Demux Operation
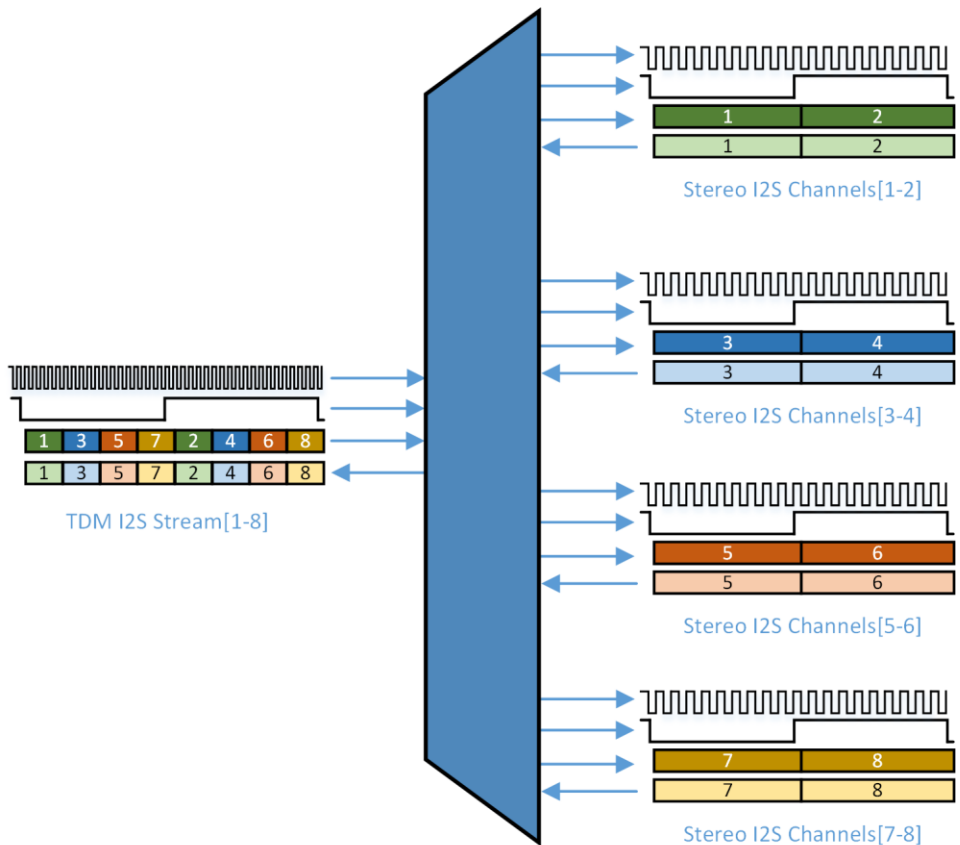
The I2S TDM peripheral splits an 8-channel TDM I2S stream into four separate stereo I2S buses. The peripheral assumes an audio channel size of 32-bits and will extract the data using that assumption. The clocks on the demuxed stereo streams are derived from the clocks on the TDM side, so they will always function as I2S masters with respect to their destinations. The derived BCLK signals on the stereo side will be four times slower than the BCLK on the TDM side.

It is possible to use as many or as few of the stereo I2S streams as is required by the end use case.

7.2 Configuring the I2S TDM Peripheral

The I2S TDM Mux/Demux is configured through the **I2S TDM** and **AIF** tabs of the Lochnagar 2 Plugin.
These two tabs must be used in combination to configure the I2S TDM peripheral.
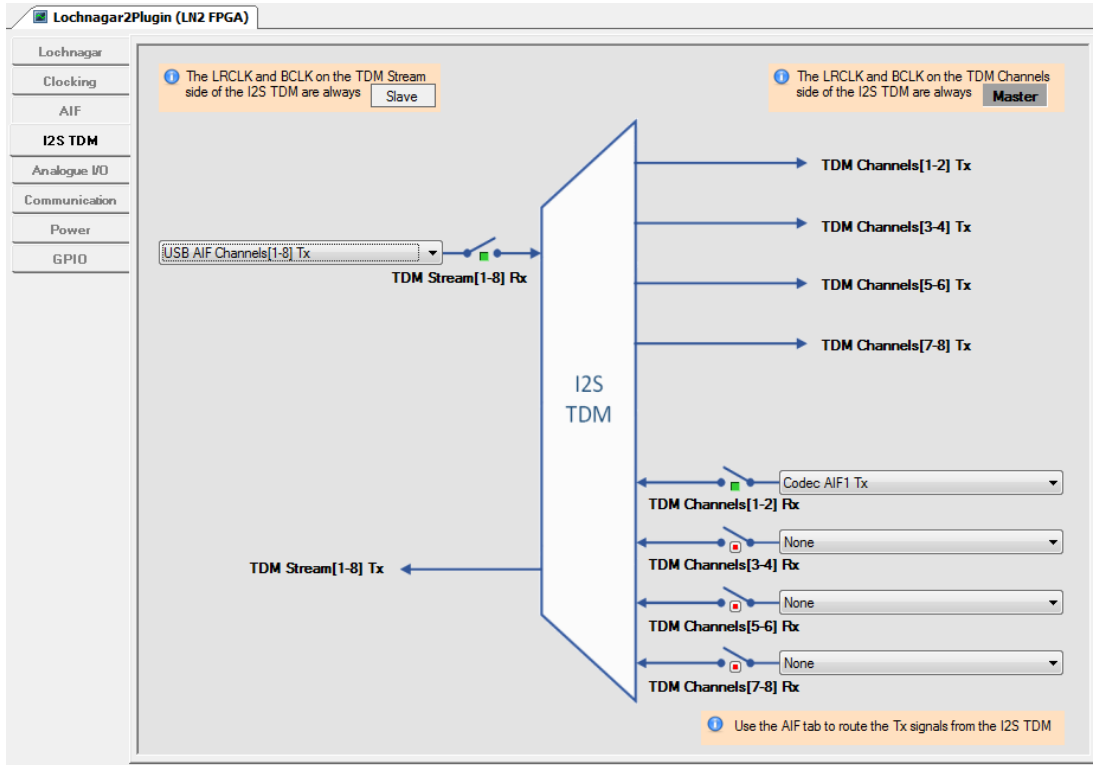
7.2.1 Example Configuration

This section will describe the steps required to connect the Lochnagar 2 USB audio streaming to the Codec AIF1 port through the I2S TDM peripheral. This will extract channels 1 and 2 of the 8-channel USB audio data and present it to Codec AIF1 as a stereo 64Fs I2S data stream. The stereo return data from the Codec AIF1 will be returned back to the USB streaming peripheral as an 8-channel I2S TDM signal from the I2S TDM Mux/Demux peripheral.

1. Set up the Codec MCLK using the **Clocking** panel of the Lochnagar 2 Plugin. As the data is coming from the USB audio streaming peripheral, one of the USB MCLK signals should be routed to Codec MCLK1. This could be either the 24.576 MHz or 12.288 MHz variant, as both are synchronous with the USB audio data.
2. On the **I2S TDM** panel, select the TDM Stream[1-8] Rx source as USB AIF Channels[1-8] Tx.
3. Click the Enable switch button next to the TDM Stream[1-8] Rx source selector box. This will change colour from red to green.
4. Select the TDM Channels[1-2] Rx source as Codec AIF1 Tx. This will route the return data from the codec back through the I2S TDM peripheral.
5. On the **AIF** panel, Select the Codec AIF1 Rx Source as TDM Channels[1-2] Tx. This will route the stereo data from the I2S TDM peripheral to the Codec AIF1.
6. Set the Codec AIF1 LRCLK and BCLK signals to Slave mode. This means that these clocks will be supplied by the I2S TDM peripheral.
7. Click the Enable button on the Codec AIF1 row.
8. Select the USB AIF Channels[1-8] Rx Source as TDM Stream[1-8] Tx. This will connect the 8-channel return path from the I2S TDM to the USB audio streaming peripheral.
9. Make sure the BCLK and LRCLK are set to Master mode in order to provide these clocks to the I2S TDM peripheral. USB Audio Streaming always operates in this mode, so no action is required in this example.

10. Set the High Frequency Mode setting for the USB AIF Channels[1-8] to Buffered mode to compensate for increased path delay in the I2S TDM peripheral.
11. Click the Enable button on the USB AIF Channels[1-8] row.

This setup is provided as one of the example scripts in the Lochnagar 2 Device Pack profile scripts directory.

7.2.2   Description of I2S TDM sinks and sources

The I2S TDM Mux/Demux is integrated with the Digital Audio routing functionality and has access to the full range of audio sources as any of the other AIF digital audio.

All I2S TDM use cases will require both **AIF** and **I2S TDM** panels of the Lochnagar 2 Plugin, as the functionality is heavily interlinked.

7.3   Clocking Restrictions

LRCLK and BCLK for the I2S TDM Mux/Demux peripheral are provided by the AIF source that is selected as the TDM Stream[1-8] Rx source. This source is selected on left side of the **I2S TDM** plugin tab. The corresponding AIF port must be set as BCLK and LRCLK Master on the **AIF** tab of the plugin, otherwise no clocks will be provided to the I2S TDM block.

Any AIF ports connected to the stereo inputs/outputs of the I2S TDM block must be set as BCLK and LRCLK Slave ports on the **AIF** page of the plugin, otherwise there will be a conflict as two clocks drive against each other.

Note that since the I2S TDM block is bidirectional, it is possible to connect different AIF ports to the upstream and downstream audio on each of the stereo and TDM sides. That is, the AIF port selected as the TDM side Channels[1-8] Rx Source must be set up as a clock Master, but this does not necessarily have to be the AIF port that receives the TDM Channels[1-8] Tx data. Due to the clocking restrictions about which ports can be masters/slaves, this can get confusing and such use cases must be treated with care.

High Frequency Mode

When using the I2S TDM block functionality, it is highly recommended to enable Buffered mode on the AIF Master that provides the I2S TDM peripheral with its BCLK and LRCLK.

The I2S TDM block will add extra latency into the audio path, and this may be enough to corrupt the return data for audio streams with high BCLK rates or long PCB traces. Enabling buffered mode will compensate for this extra round trip delay.

8 Analogue Audio

This section details the analogue audio inputs and outputs on the Lochnagar 2 board, and how to configure the routing. Analogue inputs and outputs are routed directly to the audio CODEC minicard through relays and switches. The FPGA registers control the positions of the relays, thus determining how the analogue I/O is connected to the Cirrus smart CODEC device.

8.1 Analogue Port Connection Diagrams
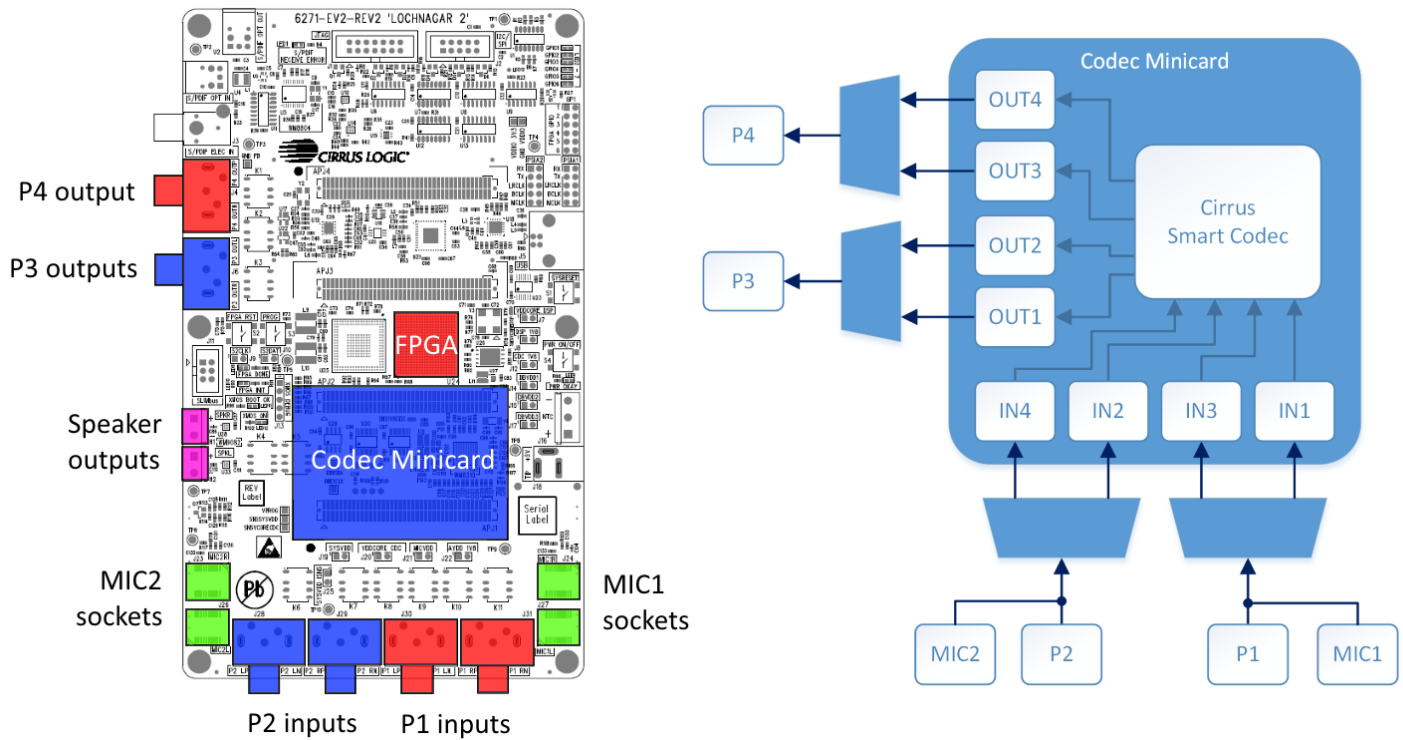
Note that for some Codec Minicards, certain inputs and outputs may be unavailable, or may be used to support other features on the minicard itself. It is therefore important to check the minicard schematic to see exactly how the input and output signals are connected to the DUT on the minicard PCB. Newer Codec WISCE Device Pack installers may provide meta-data to the Lochnagar 2 Plugin, allowing it to display some of this context-dependent routing information.

8.2 Configuring Analogue Audio Routing

Routing the various analogue audio options can be done through the **Analogue I/O** page of the Lochnagar 2 Plugin.
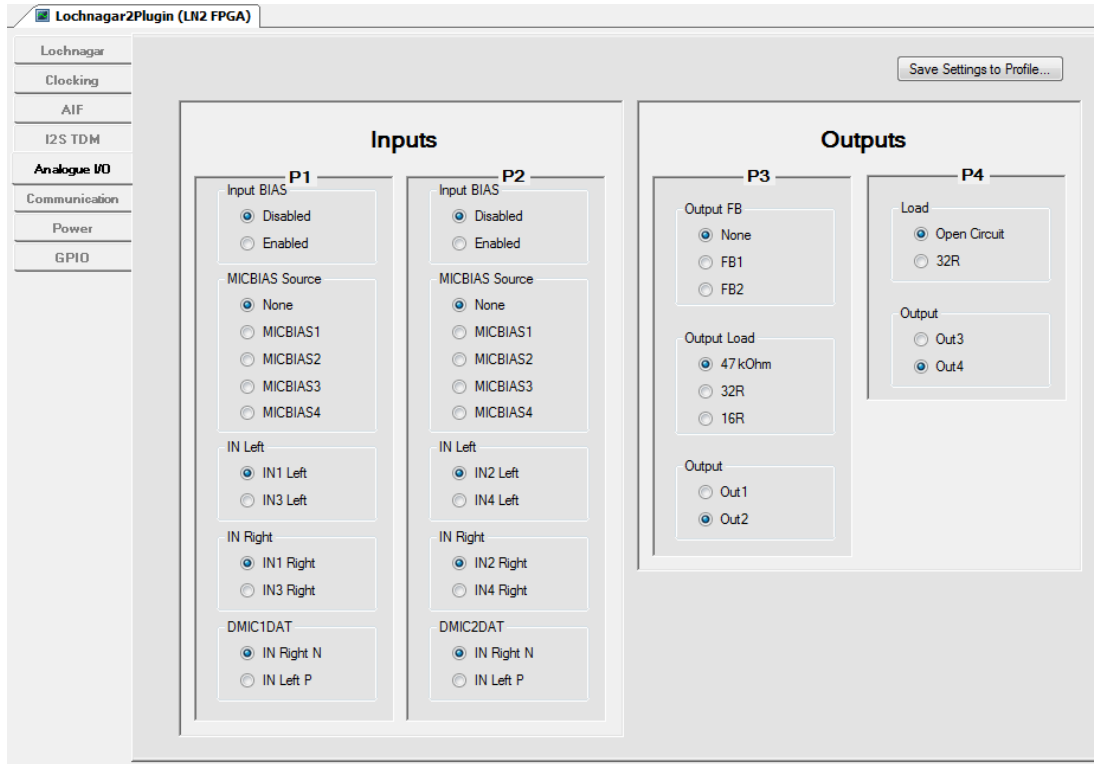
8.2.1 Save Settings to Profile

Setting the relays and checking that they have correctly switched takes a finite amount of time and a sequencing of register writes.
Saving the current values of the analogue muxing registers will not replicate the current status, as it will not perform the correct sequencing.

A button marked **Save Settings to Profile...** will export the current panel settings into a profile script that performs the analogue settings correctly.

8.3 RCA Phono Input Ports

There are two sets of phono input ports, P1 and P2, each consisting of stereo differential pair signals (Positive and Negative signals for each of Left and Right channels). These phono connectors are directly tied to the microphone input sockets, so P1 cannot be used if there are microphones plugged into either or both of the MIC1 sockets and P2 cannot be used if there is a microphone plugged into either or both of the MIC2 sockets.

8.3.1 P1 phono inputs

P1 consists of four RCA phono inputs:

- P1 LP (red)
- P1 LN (white)
- P1 RP (red)

- P1 RN (white)

P1 can be used as either two single-ended inputs (usually using P1 LN and P1 RN, the white connectors on the upper side) or as two full differential inputs (using P1 LP and LN for the left channel input, and P1 RP and RN for the right channel input).

P1 will connect to either of the following input channels on the Codec Minicard:

- IN1
- IN3

Each of the left and right channels can be routed separately (for example P1 left channel can go to IN1 while P1 right channel goes to IN3).
This selection is made in the plugin.

Note that for some Codec Minicards, certain inputs may be unavailable, or may be used for other features (eg. headset feedback signals). It is therefore important to check the minicard schematic to see exactly how the input signals are connected on the minicard PCB. Newer Codec WISCE Device Pack installers may provide meta-data to the Lochnagar 2 Plugin, allowing it to display some of this context-dependent routing information.

8.3.2 P2 phono inputs

P2 consists of four RCA phono inputs:

- P2 LP (red)
- P2 LN (white)
- P2 RP (red)
- P2 RN (white)

P2 can be used as either two single-ended inputs (usually using P2 LN and P2 RN, the white connectors on the upper side) or as two full differential inputs (using P2 LP and LN for the left channel input, and P2 RP and RN for the right channel input).

P2 will connect to either of the following input channels on the Codec Minicard:

- IN2
- IN4

Each of the left and right channels can be routed separately (for example P2 left channel can go to IN2 while P2 right channel goes to IN4).
This selection is made in the plugin.

Note that for some Codec Minicards, certain inputs may be unavailable, or may be used for other features (eg. headset feedback signals). It is therefore important to check the minicard schematic to see exactly how the input signals are connected on the minicard PCB. Newer Codec WISCE Device Pack installers may provide meta-data to the Lochnagar 2 Plugin, allowing it to display some of this context-dependent routing information.

8.3.3 Input BIAS

It is possible to connect a MICBIAS voltage directly to the P channels of the RCA phono inputs by enabling the "Input BIAS" feature in the Lochnagar 2 Plugin. This connects the RCA inputs to the MICBIAS voltage selected in the "MICBIAS Source" selection and allows external ECM microphones to be connected to the RCA connectors. See the microphones' MICBIAS section for more details.

8.4 Analogue/Digital Microphones

The microphone sockets MIC1 and MIC2 allow up to four digital or analogue microphone mincards (also referred to as 'MIC coupons'). The full range of Cirrus analogue and digital microphones can be connected to the Lochnagar 2 system.

- The MIC1 sockets are directly tied to the P1 analogue RCA inputs - if the MIC1 sockets are in use, then the P1 RCA connectors cannot be used.
- The MIC2 sockets are directly tied to the P2 analogue RCA inputs - if the MIC2 sockets are in use, then the P2 RCA connectors cannot be used.

The routing options selected for P1 and P2 within the plugin will apply to the microphone inputs as they would to the RCA analogue inputs.

8.4.1 MICBIAS

The microphone sockets can be powered from one of up to four MICBIAS outputs on the Codec Minicard. This selection is made within the plugin.

Mic socket	MICBIAS Source options
MIC1 (P1)	• None • MICBIAS1 • MICBIAS2 • MICBIAS3 • MICBIAS4
MIC2 (P2)	• None • MICBIAS1 • MICBIAS2 • MICBIAS3 • MICBIAS4

Note that some Codec Minicards may not have four MICBIAS outputs due to limitations of certain Cirrus Smart Codec devices. It is therefore important to always check the minicard schematic to see exactly how the output signals are connected on the minicard PCB. Newer Codec WISCE Device Pack installers may provide meta-data to the Lochnagar 2 Plugin, allowing it to display some of this context-dependent routing information.

8.4.2 Analogue Mics

When used with an analogue microphone coupon, the inputs will be connected as follows:

Mic socket	Minicard connector
MIC1L	Differential P1 INLP and P1 INLN
MIC1R	Differential P1 INRP and P1 INRN
MIC2L	Differential P2 INLP and P2 INLN
MIC2R	Differential P2 INRP and P2 INRN

Note that for some Codec Minicards, the connections from P1 and P2 may be routed to differently numbered input pins on the Cirrus Smart Codec itself. It is therefore important to always check the minicard schematic to see exactly how the output signals are connected on the minicard PCB. Newer Codec WISCE Device Pack installers may provide meta-data to the Lochnagar 2 Plugin, allowing it to display some of this context-dependent routing information.

8.4.3 Digital Mics

When used with a digital microphone coupon, the inputs will be connected as follows, depending on the DMICnDAT_SEL setting:

Mic socket	DMICDAT_SEL = 0	DMICDAT_SEL = 1
MIC1L and MIC1R	Clock: P1 INLN, Data: P1 INRN	Clock: P1 INLN, Data: P1 INLP
MIC2L and MIC2R	Clock: P2 INLN, Data: P2 INRN	Clock: P2 INLN, Data: P2 INLP

Both left and right channel microphones use the INLN and INRN connectors. The stereo data signals are transmitted on either positive or negative clock edges depending on which of the MICnL/MICnR sockets the coupon is plugged into.

Some Smart Codec devices require the DMIC data signal to be connected to the the INRN analogue input on the Smart Codec, and some require that it connects to the INLP pin. Lochnagar 2 provides a relay switch that allows it to be connected to either of these input pins on the Smart Codec minicard. There will therefore be a required DMICDAT_SEL setting for each minicard that routes the DMICDAT signals to the appropriate pins.

Note that for some Codec Minicards, the connections from P1 and P2 may be routed to differently numbered input pins on the Cirrus Smart Codec itself. It is therefore important to always check the minicard schematic to see exactly how the output signals are connected on the minicard PCB. Newer Codec WISCE Device Pack installers may provide meta-data to the Lochnagar 2 Plugin, allowing it to display some of this context-dependent routing information.

8.5 RCA Phono Output Ports

There are two sets of phono output ports, P3 and P4.
P3 is a stereo single-ended output pair, P4 is a mono differential output.

8.5.1 P3 phono outputs

P3 is a pair of single-ended RCA phono outputs:

- P3 OUTR (red)
- P3 OUTL (white)

P3 can be connected to either of the following output channels on the Codec Minicard:

- OUT1
- OUT2

Note that for some Codec Minicards, certain outputs may be unavailable, or may not be routed down to the Lochnagar 2 board. It is therefore important to check the minicard schematic to see exactly how the output signals are connected on the minicard PCB. Newer Codec WISCE Device Pack installers may provide meta-data to the Lochnagar 2 Plugin, allowing it to display some of this context-dependent routing information.

8.5.1.1 Output FB

The feedback signal from P3 can be routed back to one of the following minicard feedback pins:

- FB1
- FB2
- None

8.5.1.2 Output Load

The P3 output signals can have one of the following loads applied:

- 47 kOhm
- 32 Ohm
- 16 Ohm

8.5.2 P4 phono output

P4 is a single channel differential RC phono output:

- P4 OUTN
- P4 OUTP

P4 can be connected to either of the following output channels on the Codec Minicard:

- OUT3
- OUT4

Note that for some Codec Minicards, certain outputs may be unavailable, or may not be routed down to the Lochnagar 2 board. It is therefore important to check the minicard schematic to see exactly how the output signals are connected on the minicard PCB. Newer Codec WISCE Device Pack installers may provide meta-data to the Lochnagar 2 Plugin, allowing it to display some of this context-dependent routing information.

8.5.2.1 Output Load

The P4 output signals can have one of the following loads applied:

- None (Open-circuit/CCT)
- 32 Ohm

8.6 Speaker Outputs

Lochnagar 2 is equipped with two screw-terminal speaker outputs, SPKL and SPKR which are powered by discrete Cirrus WM9082 speaker amplifiers. The central Lochnagar 2 FPGA can route PDM output signals from the Codec Minicard to these terminals. The speaker outputs are connected to the PDM output 1 pins from the Codec Minicard.

8.7 Analogue I/O on the minicard

Most smart codec audio minicards provide several analogue output ports. These usually consist of:

- 4-pole 3.5 mm Headset connector
- Earpiece output (screw terminals)
- Speaker outputs (screw terminals)

This will vary from minicard to minicard, so it is important to check the minicard schematics.

Minicards with a headset connector will often use one of the Cirrus device's analogue inputs to provide a feedback signal for the headphone connector. This means that it may not be possible to use that particular analogue input at the same time as using the headset output on the minicard. Check the minicard schematics to see which analogue input ports are affected by minicard board routing. Newer Codec WISCE Device Pack installers may provide meta-data to the Lochnagar 2 Plugin, allowing it to display some of this context-dependent routing information.

9 GPIOs

Lochnagar 2 provides advanced GPIO routing support that allows the full flexibility of any-to-any pin mapping.

With the increases in flexibility in GPIO usage that chips such as Clearwater and Moon bring over previous generations, Lochnagar 2 now also provides a similar level of control at the board level. On Clearwater onwards, there are at least 8 dedicated GPIO pins per chip, and in addition most digital I/O can also be used in GPIO mode, giving around 40 potential GPIO signals per chip. Lochnagar 2 allows any of these pins to be used in GPIO mode and allows them to be routed to any other digital I/O, regardless of the pin's default function.

Lochangar 2 allows for up to 16 pairs of pins to be mapped as GPIOs at any one time.

9.1 Setting up GPIO routing

GPIO routing setup is controlled through the Lochnagar 2 Plugin.
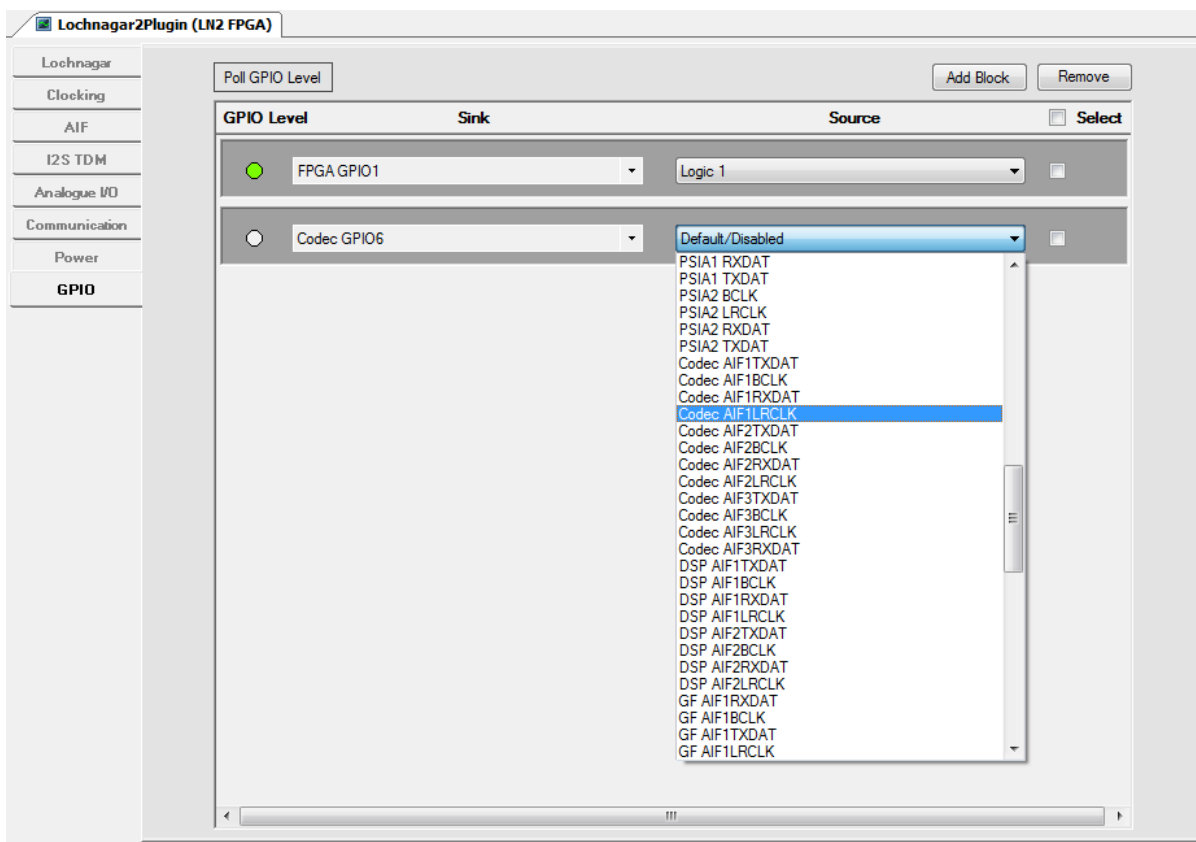
1. Select the GPIO panel to begin setting up any-to-any pin GPIO connections.
2. Select "Add Block" to create a connection between two GPIO pins
3. Select the "Sink" from the left-hand drop-down list. The FPGA will actively drive onto this pin as an output
4. Select the "Source" from the right-hand drop-down list. The FPGA will use this pin as an input, and map the values onto the Sink pin.
5. If a GPIO connection is no longer required, mark the checkbox next to the connection and click the "Remove" button.

Note that if a GPIO pin on the system is used by another function, such as AIF, the plugin will highlight the AIF panel and display warnings to indicate that one of the AIF pins is being used as a GPIO and may not function correctly.

9.2   GPIO level

The Lochnagar 2 can display the current logic level for all signals that are routed through the GPIO system.

Click the "Poll GPIO Level" button in the top-left corner of the plugin's GPIO panel to enable this feature.
The logic high/low level for each GPIO will be displayed in the green circle to the left of the GPIO sink.
The green arrows next to "GPIO Level" indicate that the plugin is currently polling, and the logic states shown in the plugin are up-to-date.

Note that enabling this feature will generate a lot I2C traffic in the WISCE history window as the plugin polls the Lochnagar 2 board to read the current logic levels. The refresh rate will depend on many elements including PC speed and amount of other USB traffic on the bus.
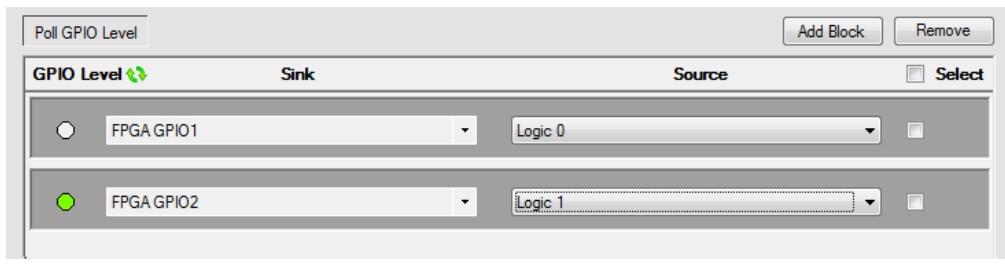
9.3   Lochnagar 2 on-board GPIOs/LEDs

Lochangar 2 has six dedicated GPIO pins for debug purposes, which are accessible through the GP1 header on the top-right corner of the board.
These are listed in the plugin and register map as **FPGA GPIO1** to **FPGA GPIO6**.
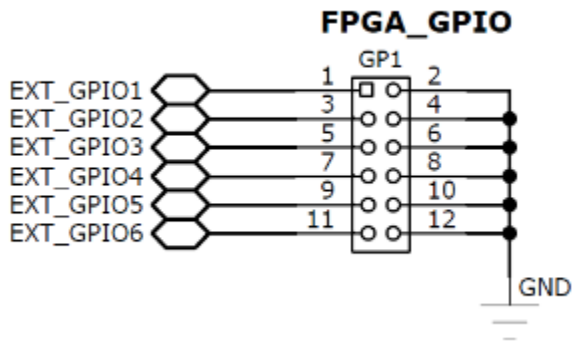
The six dedicated GPIOs are tied directly to the bank of six LEDs in the same corner of the Lochnagar 2 board, such that the logic values on the GPIOs can be observed visually without the need for an oscilloscope. The value on the pins can also be read back by software. This is done by setting up "FPGA GPIOn" as a GPIO sink and enabling the polling feature from the Lochnagar 2 Plugin.

> The Lochnagar 2 GPIO pins operate on the 3.3V voltage domain.

9.4   GPIOs on Codec Minicards

Codec Minicards have reserved pins for up to eight dedicated GPIO signals from the Cirrus Smart Codec. At present, no Cirrus Smart Codec has more than 8 dedicated GPIO pins. The positions of other shared-function GPIO pins will change from chip to chip, so GPIO16 may be an AIF pin on some devices or a PDM pin on others. For this, it is vital to check the device datasheet to correlate GPIO numbers & pin functions.

It is also worth noting that some devices have less than eight dedicated GPIO pins and therefore these signals will be left floating on the minicard.

Depending on the minicard design, it is probable that the schematic will be using at least one of the eight available GPIO pins on the Cirrus Smart Codec for a fixed function such as clock output or headset polarity switching. As such, even if the device has eight dedicated GPIO pins, it is likely that only a subset of these GPIO pins will be routed down to the Lochnagar 2 board & FPGA. For this reason, it is vital to consult the schematics for the minicard to ensure that the GPIO you are trying to use is actually connected.

9.5   Descriptions of GPIO sinks and sources

This section lists and describes the pins that can be used as GPIO sinks and GPIO sources using the Lochnagar 2.

9.5.1   GPIO Sink List

This chooses which pin you wish to use as a GPIO. This may be a dedicated GPIO pin, or a digital I/O pin that has an alternate function (eg. digital audio LRCLK pin). This pin will be driven as an output from the FPGA with the value of the source signal selected in the GPIO source list. The register map addresses associated with these GPIO sinks is provided for advanced users.

Name	Related Registers	Description
None		No GPIO sink has been selected
FPGA GPIOn	R31h - R36h	Drives out onto one of the 6 pins on the GPIO Header / LED Bank
Codec GPIOn	R37h - R3Eh	Drives out onto one of the 8 dedicated GPIO pins on the Codec Minicard
DSP GPIOn	R3Fh - R44h	Drives out onto one fo the 6 dedicated GPIO pins on the DSP Minicard
GF GPIOn	R45h - R47h	Drives out onto one of the 3 dedicated GPIOs on the underside Expansion Headers
Codec AIFnBCLK/RXDAT/LRCLK/TXDAT	R48h - R53h	Drives out onto the AIF pins on the Codec Minicard
DSP AIFnBCLK/RXDAT/LRCLK/TXDAT	R54h - R5Bh	Drives out onto the AIF pins on the DSP Minicard
PSIAn BCLK/RXDAT/LRCLK/TXDAT	R5Ch - R63h	Drives out onto the pins on the PSIA headers
GF AIFnBCLK/RXDAT/LRCLK/TXDAT	R64h - R73h	Drives out onto the AIF pins on the underside Expansion Header
DSP UARTn RX/TX	R74h - R77h	Drives out onto the UART pins on the DSP Minicard
GF UART2 RX/TX	R78h - R79h	Drives out onto the UART pins on the underside Expansion Header
USB UART RX	R7Ah	Drives out onto the UART RX pin of the Generic USB UART device
Codec PDMCLK/DATn	R7Ch - R7Fh	Drives out on the PDM pins on the Codec Minicard
Codec DMICCLK/DATn	R80h - R87h	Drives out onto the DMIC pins on the Codec Minicard
DSP DMICCLK/DATn	R88h - R8Bh	Drives out onto the DMIC pins on the DSP Minicard
I2Cn SCL/SDA	R8Ch - R91h	Drives out onto the I2C pins of systemwide I2C buses 2, 3 or 4
DSP STANDBY N	R92h	Drives out onto the 'standby' pin on the DSP Minicard
Codec MCLKn	R93h - R94h	Drives out onto the MCLK pins on the Codec Minicard
DSP CLKIN	R95h	Drives out onto the CLKIN pin on the DSP Minicard
PSIAn MCLK	R96h - R97h	Drives out onto the MCLK pins on the PSIA headers

9.5.2 GPIO Source List

This logic value on the selected source will be will be applied to the GPIO sink pin selected in the GPIO sink list. The binary values are provided for advanced users.

Name	Binary Value	Description
Default/Disabled	0x00	Not used as a GPIO
FPGA_GPIOn	0x00 - 0x06	Connects to one of the 6 pins on the Lochnagar 2 GPIO Header / LED Bank
CDC_GPIOn	0x07 - 0x0E	Connects to one of the 8 dedicated GPIO pins on the Codec Minicard
DSP_GPIOn	0x0F - 0x14	Connects to one of the 6 dedicated GPIO pins on the DSP Minicard
GPIOn_GF	0x15 - 0x17	Connects to one of the 3 dedicated GPIOs on the underside Expansion Headers
CDC_CLKOUT	0x20	Connects to the clock output pin of the Codec Minicard
DSP_CLKOUT	0x21	Connects to the clock output pin of the DSP Minicard
PMIC_32K	0x22	Connects to the 32.768 kHz output clock from the PMIC chip
SPDIF_CLKOUT	0x23	Connects to the 12 MHz output clock from the S/PDIF Transceiver chip
CLK_12.288MHz	0x24	Connects to the 12.288 MHz clock from the onboard clock generator chip
CLK_11.2986MHz	0x25	Connects to the 11.2986 MHz clock from the onboard clock generator chip
CLK_24.576MHz	0x26	Connects to the 24.576 MHz clock from the onboard clock generator chip
CLK_22.5792MHz	0x27	Connects to the 22.5792 MHz clock from the onboard clock generator chip
USB_MCLK	0x29	Connects to the USB MCLK: 24.576 MHz (22.5792 MHz) signal. Frequency will depend upon sampling rate of audio being transferred over USB. Will be either 24.576 MHz or 22.5792 MHz.
GF_CLKOUTn	0x2A, 0x2E	Connects to the one of the clockout signals going to the underside Expansion Headers
GF_MCLKn	0x2B, 0x2D, 0x2C	Connects to the MCLK signals coming from the underside Expansion Headers
CDC_MCLKn	0x2F - 0x30	Connects to one of the 2 MCLK signals going to the Codec Minicard
DSP_CLKIN	0x31	Connects to the CLKIN signal going to the DSP Minicard
PSIAn_MCLK	0x32 - 0x34	Connects to the MCLK signals coming from / going to the PSIA headers
SPDIF_MCLK	0x34	Connects to the MCLK signal coming from the S/PDIF transceiver. Frequency will depend upon the sampling rate of the audio.
CDC_IRQ_N	0x42	Connects to IRQ signal coming from the Codec Minicard
CDC_RST_N	0x43	Connects to hard reset signal going to the Codec Minicard
DSP_RST_N	0x44	Connects to hard reset signal going to the DSP Minicard
DSP_IRQ_N	0x45	Connects to IRQ signal coming from the Codec Minicard
DS_STANDBY_N	0x46	Connects to Standby signal going to the Codec Minicard
PSIAn_BCLK/LRCLK/RXDAT/TXDAT	0x50 - 0x57	Connects to the PSIA header pins
CDC_AIFnBCLK/LRCLK/RXDAT/TXDAT	0x58 - 0x63	Connects to the AIF pins on the Codec Minicard
DSP_AIFnBCLK/LRCLK/RXDAT/TXDAT	0x64 - 0x6B	Connects to the AIF pins on the DSP Minicard
GF_AIF3BCLK/LRCLK/RXDAT/TXDAT	0x6C - 0x7B	Connects to the GF AIF3 pins on the underside Expansion Headers
CDC_PDMCLK/DATn	0x90 - 0x93	Connects to the PDM signals on the Codec Minicard
CDC_DMICCLK/DATn	0xA0 - 0xA7	Connects to the DMIC signals on the Codec Minicard
DSP_DMICCLK/DATn	0xA8 - 0xAB	Connects to the DMIC signals on the DSP Minicard
DSP_UARTn_RX/TX	0xC0 - 0xC3	Connects to the UART signals on the DSP Minicard
GF_UARTn_RX/TX	0xC4 - 0xC5	Connects to the UART signals on the underside Expansion Headers
USB_UART_RX/TX	0xC6 - 0xC7	Connects to the UART signals coming from the USB interface
I2Cn_SCL/SDA	0xE0 - 0xE5	Connects to the various I2C buses on the Lochnagar 2 system
Logic 0	0xFE	Applies a logic '0' signal
Logic 1	0xFF	Applies a logic '1' signal

10 JTAG

The Lochnagar 2 has JTAG debugging functionality built in through the USB interface, and does not require any third party adapters for on-chip debugging of ADSP2 cores.
The JTAG header J1 is still present on the Lochnagar 2 board, so it is still possible to use an external controller such as the Macraigor usb2Wiggler if required.

10.1 Required Chess toolchain update

Some machines in combination with some versions of the Synopsys Chess toolchain may have trouble connecting JTAG on Lochnagar 2 platforms.
In this situation, ChessDE always reports that the PM0 contents are 0xFFFFFF.

If observed, it is recommended to update to the latest version of the Synopsys Chess toolchain.

10.2 JTAG configuration

JTAG settings on Lochnagar 2 are configured via the "Communication" panel on the Lochnagar 2 Plugin.


JTAG can be sourced from one of two sources:

- USB: JTAG interface to computer via the Lochnagar 2 USB cable
- External Header: 14-pin J1 "JTAG" header at top of Lochnagar 2 board. This can be used with standard JTAG dongles such as Macraigor usb2Wiggler (U2W-ONCE variant)

JTAG can be used to debug DSP cores on either of the Codec or DSP minicard headers. The same JTAG source cannot be used for both Codec and DSP minicard devices.

10.2.1 Example configuration

1. Make sure that the Lochnagar 2 board is connected to the PC via the USB cable.
2. Enable JTAG from USB to the Codec minicard in the Lochnagar 2 plugin:
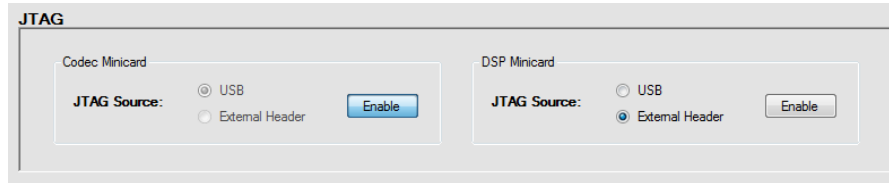
3. In the Chess Project settings, select the FTDI USB-MPSSE Interface cable, a TCK frequency divider of 5, and an extra argument of -d1.
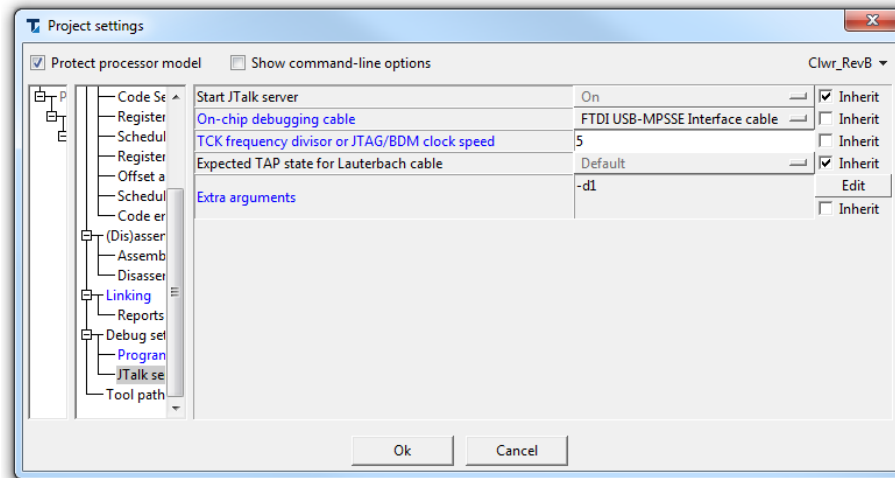
4. Rebuild the Chess project and download it to the Cirrus Smart Codec device in the usual way.
5. Ensure the debug clock is enabled on the Cirrus Smart Codec device, and that the core is programmed and running.
6. It should now be possible to start debugging from the ChessDE environment in the usual way.

The correct core must be specified in the Chess 'Debug settings' menu. This is done by specifying 'core=n', where n is the core number from 1-7. Make sure that the build configuration in the top-right corner is set to the correct chip, rather than <All>. If not specified, Chess will default to debugging core 1.
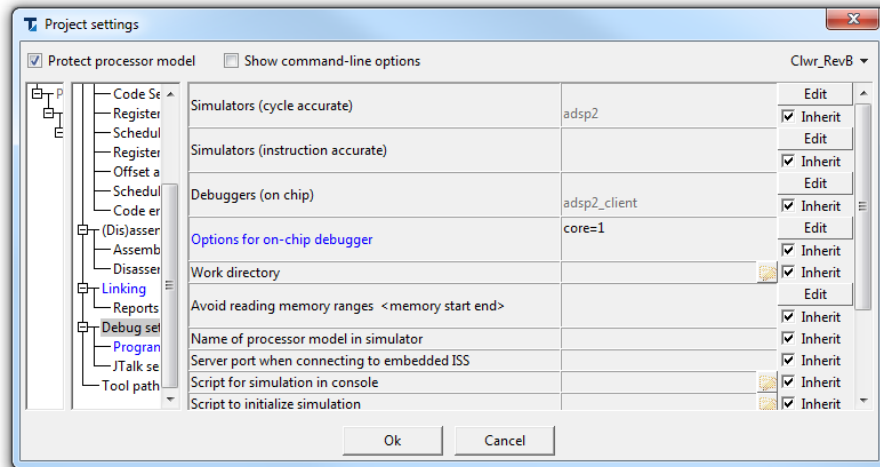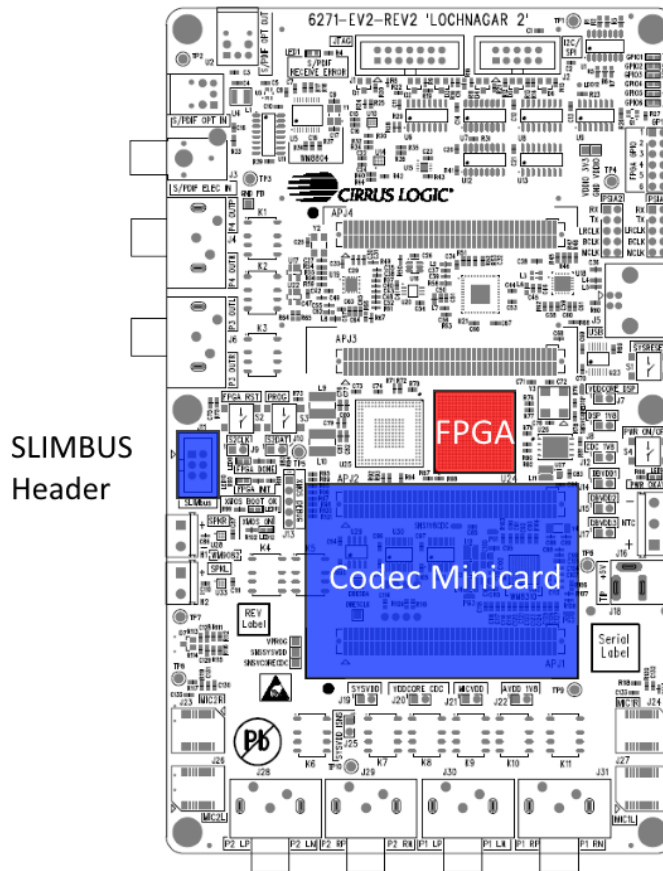
11 SLIMbus

Cirrus Smart Codec devices on Lochnagar 2 can be controlled using the SLIMbus protocol.

SLIMbus is an interface protocol that can be used for both control (i.e. writing to Codec register map) and audio transport. It is a very flexible protocol which can be changed dynamically to facilitate high and low bandwidth traffic as efficiently as possible. With Mutliline SLIMbus, this is further improved with extra data lines specifically used for data transport, as well as other updates/features to improve firmware transfer rates.

Lochnagar 2 does not natively support this format through USB. Third-party equipment must be used to connect through the J11 "SLIMbus" header on the board. An Application Processor connected to the Expansion Headers on the underside of Lochnagar 2 can also use the SLIMbus protocol to communicate with the Smart Codec using SLIMbus protocol.

11.1 SLIMbus Header

The signals from the SLIMbus Connector J11 are routed directly to the Codec Minicard and can be used to control it directly.

No additional register configuration is required on the Lochnagar 2 board to enable this.

J11 Pin	Signal
1	SLIMCLK
2	GND
3	SLIMDAT
4	GND
5	n/c
6	GND

11.2 SLIMbus through Expansion Headers

The expansion headers on the underside of Lochnagar 2 are connected to the Codec Minicard SLIMbus signals. If an Application Processor that supports SLIMbus protocol is connected to the Lochnagar 2 expansion headers, it can be used to control the Smart Codec via this interface.
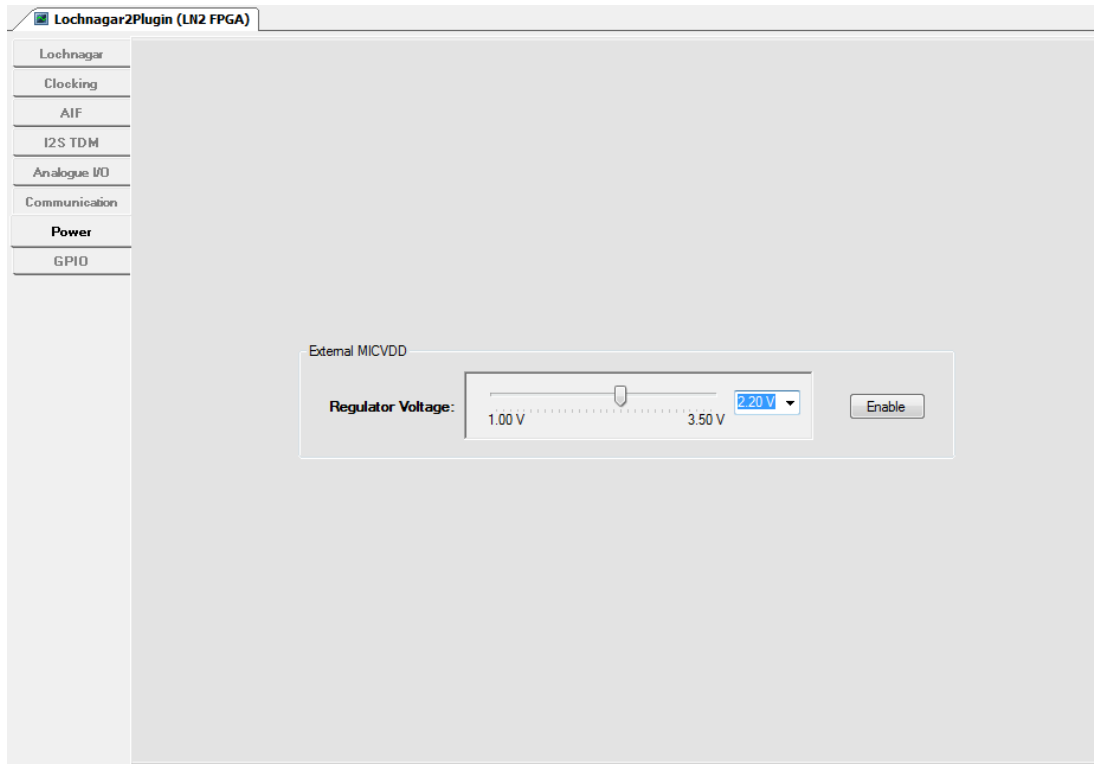
No additional register configuration is required on Lochnagar 2 to enable this.

12 Power

The Lochnagar 2 provides a level of configuration for the power supply rails on the board. The MICVDD rail is at present the only configurable voltage rail.

12.1 Configuring Power Options

The power rail options are configured through the **Power** tab of the Lochnagar 2 Plugin.

12.2 MICVDD Options

Most Cirrus Smart Codec devices generate their own MICVDD voltages from an internal regulator and therefore this power rail is usually an output from the Codec minicard.

However, some Smart Codecs do not have an internal regulator and require MICVDD to be supplied as an input to the chip. Lochnagar 2 provides the option to generate voltage on the MICVDD rail and supply it to the chip. The voltage can be configured as any value between 1.00 V and 3.50 V, stepping in 0.05 V increments between 1.00 and 1.60 V and 0.1 V increments between 1.60 and 3.50 V.

12.2.1 Example Configuration

To configure the MICVDD voltage:

1. Navigate to the **Power** tab of the Lochnagar 2 Plugin.
2. Select the desired voltage level from the slider / drop-down menu.
3. Click the "Enable" button to supply this voltage on the MICVDD rail.

MICVDD should only be enabled on the Lochnagar 2 for devices that do not generate their own MICVDD voltage internally.

13 Current Monitor

Lochnagar 2 features built-in Current Monitor circuitry that allows for the measurement of both voltage and current on up to eight of the supply voltage rails provided to the minicards. The Current Monitor does not require any hardware modifications or external circuitry to operate. The current and voltage measurements are obtained through the standard register map interface to the Lochnagar 2 FPGA, and can therefore be monitored by software.

13.1 Lochnagar 2 Power Rails

The current monitor is provided for indication purposes only and not as an absolute measurement.

All rails are accurate to roughly 1% for all measurements above 1 mA.

For greater accuracy, a removable jumper is provided on each rail to allow for the serial insertion of an external multimeter.

13.1.1 Monitored Voltage Rails

Channel	Rail	Minicard	Jumper	Notes
1	DBVDD1	Codec	J14	
2	1V8 DSP	DSP / Codec	J8	
3	1V8 CDC	Codec	J12	
4	VDDCORE DSP	DSP / Codec	J7	
5	AVDD 1V8	Codec	J22	
6	SYSVDD	Codec	J25	• It is not possible to measure voltage on the SYSVDD rail. • Current measurements on the SYSVDD rail will have a fixed offset that varies from board to board. It is recommended to calibrate SYSVDD current measurements by measuring the current with no minicard connected to determine this offset, or by connecting an external multimeter to verify.
7	VDDCORE CDC	Codec	J20	
8	MICVDD	Codec	J21	• Voltage monitor readback will saturate at 2.5 V, although this rail is capable of running up to 3.3 V.

The channel number determines the order that the rails are displayed within the Current Monitor plugin and is used by the register interface to trigger readings on each of the rails.

The minicard column shows which minicard type this power rail can power. The DSP power rails can also be used by 3-header Codec cards that span headers APJ1 to APJ3. Note that not all minicards will use all the available power supplies, and that sometimes minicard schematic designers may choose to connect various supply rails together. For example, the DBVDD1 supply rail from Lochnagar may be left disconnected on the minicard if the designer has chosen to connect the Smart Codec's DBVDD1 pin to the generic 1V8 CDC rail instead.

13.1.2 Unmonitored Voltage Rails

There is no provision to monitor the following voltage rails using the built-in Current Monitor. To measure current on these rails, remove the appropriate jumper and insert a digital multimeter in serial between the two pins of the jumper header.

Rail	Minicard	Jumper
DBVDD2	Codec	J15
DBVDD3	Codec	J17

13.2 Current Monitor Plugin

The Current Monitor is accessed through the Lochnagar 2 Register Map. The interface requires a complex sequence of register writes in order to trigger and interpret measurements, so this has been simplified by providing a plugin interface.The **Current Monitor** plugin is provided separately to the main **Lochnagar2Plugin**. Having them separate allows the user to undock and view the two plugins simultaneously. Both can be accessed from the "Tuning" folder of the LN2 FPGA device in the WISCE Systems tree.
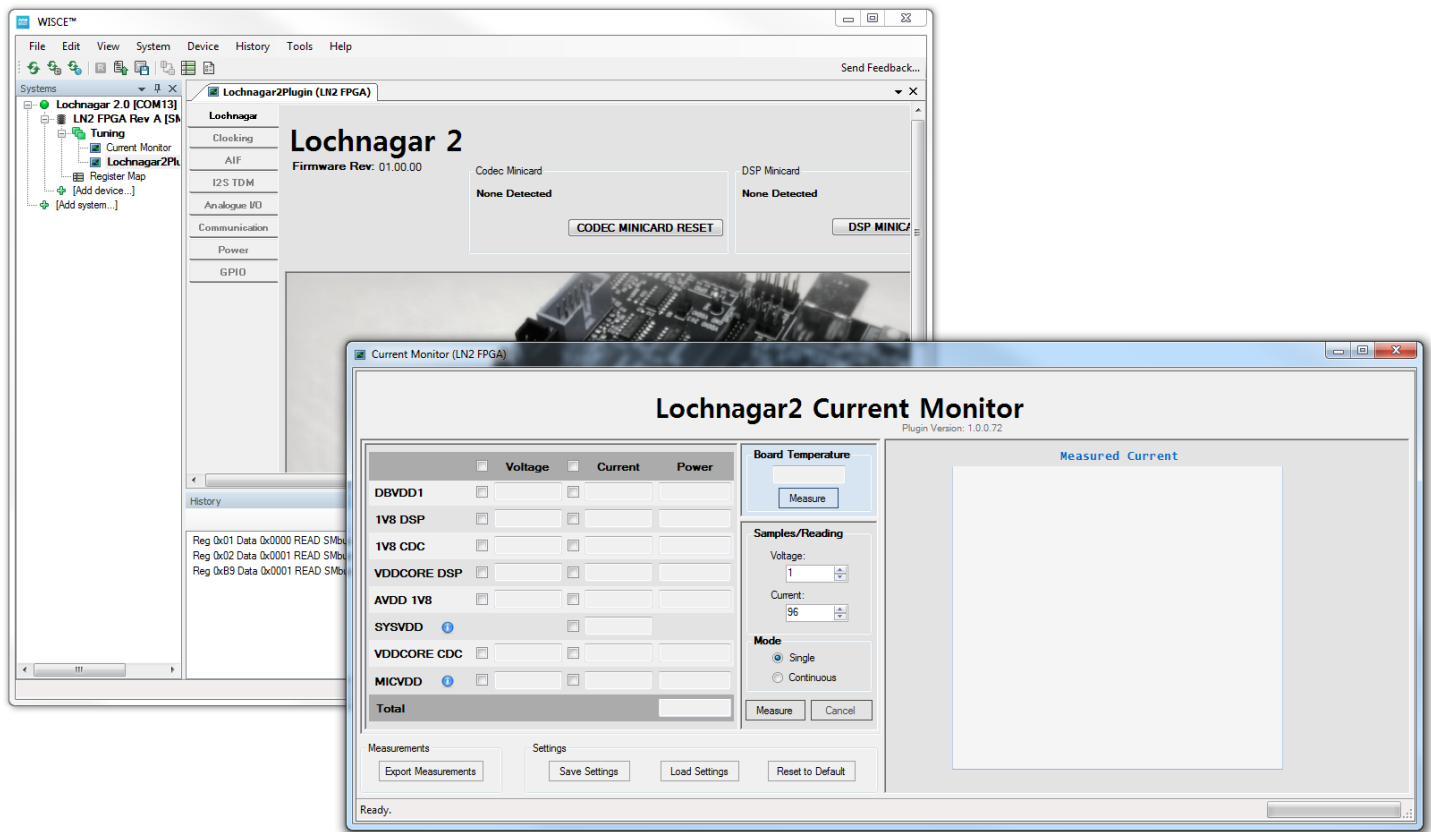
13.2.1 Voltage / Current Rail Selection

Two checkboxes are provided for each of the measureable rails: one for measuring voltage, the other for current. At the top of each column, there is an additional checkbox that allows all voltages or current checkboxes to be selected/deselected in a single click.

When a measurement is triggered in either Single or Continuous mode, the current monitor plugin will measure all currents and voltages that are currently checked. The operation will take longer when more checkboxes are ticked.

13.2.2 Power Measurement

If both Voltage and Current measurements are selected for the same rail, the plugin will also calculate the power consumed on that rail by multiplying the values together. It will also automatically sum all of the calculated power values into a total, displayed underneath the table. This applies to both Single and Continuous measurement modes.

13.2.3 Measurement Modes

13.2.3.1 Single

In Single Measurement Mode, pressing the "Measure" button will trigger a single measurement of all voltages and currents that are currently checked. The values will be displayed in the boxes next to the checkbox. Graphing is disabled in Single Measurement Mode.

13.2.3.2 Continuous

In Continuous Measurement Mode, the "Measure" and "Cancel" buttons will change into "Start" and "Stop" buttons. The Current Monitor plugin will repeatedly trigger measurements of all selected voltages and currents until the "Stop" button is pressed. When in continuous measurement mode, the plugin will also chart the selected current measurements on a graph for ease of visibility over time. The refresh rate of the measurements/graph will depend on how many currents and voltages are being simultaneously measured.

13.2.4 Samples/Reading

These parameters control the filtering performed by the current measurement circuitry, and determine how many raw samples are required in order to obtain one voltage or current measurement. Each parameter is in the range 1-1023. The higher this number, the more samples are used to produce a voltage or current measurement value. High numbers will result in slower but more precise measurements. Low values will result in faster but less precise measurements.

The recommended default values for the Samples/Reading settings are:

Measurement Type	Default S/R
Voltage	1
Current	96

13.2.5 Export Measurements

The Export Measurements button will take the current set of measurements displayed in the plugin and save them as a Comma Separated Values (CSV) file that can be opened in a spreadsheet or text editor.

13.2.6 Save/Load/Restore Settings

The Current Monitor plugin will automatically store the current configuration (selected checkboxes, samples/reading settings and measurement mode) as an XML file and will automatically restore them the next time the plugin is opened. This means that the user does not have to re-select their desired current or voltage rails every time the WISCE application is opened. The "Save Settings" button allows the user to save a copy of the XML file to their hard drive in order to share it with others, or quickly switch between different Current Monitor configuration. The "Load Settings" button allows the user to load in a previously saved XML file to restore those settings. The "Restore to Default" button will reset all options in the plugin back to their default values.

13.2.7 Board Temperature

Press the "Measure" button to perform a temperature measurement on the Lochnagar 2 board.

The temperature will be measured by U41 on the underside of Lochnagar 2. The measurement capability of this chip is accurate to +/- 2 degrees Celsius.

14 Example Setup Scripts

This page details the example setup scripts provided as part of the WISCE™ Device Pack. Scripts are not backwards/forwards compatible between Lochnagar 2 and the original Lochnagar board.

14.1 WISCE™ Profile Scripts

A WISCE™ Profile Script is a text file containing a sequence of register reads and writes. Each line of the text file contains a separate register read or write command. Profile Scripts are used to automate chip setup for Cirrus devices, to replicate existing setups and/or return the board to a known configuration.

Profile Scripts can:

- Write to multiple devices on the system
  - For example, the same profile script can write to registers on a Cirrus Smart Codec device and also to the Lochnagar 2 FPGA.
- Recursively call other Profile Scripts
  - For example, a common set up of Lochnagar 2 FPGA setup scripts can be called by a variety of higher level scripts that configure both the LN2 board and Codec device.

The WISCE™ Profile Scripts provided with the Lochnagar 2 WISCE™ Device Pack are installed automatically to the following directory:

`C:\Program Files (x86)\Wolfson Evaluation Software\Profiles\Lochnagar2`

Assuming that the WISCE™ application has been installed to the default installation directory. The "Profiles" folder of the WISCE™ installation directory should be the default search path when the user clicks on File->Load.. within the WISCE™ application. Profile Scripts are run from within WISCE™ by clicking on *File->Load...* and selecting the appropriate Profile Script text file.

14.2 Lochnagar 1 and Lochnagar 2 Register Compatibility

Lochnagar 2 registers are in a different format to the registers of the original Lochnagar board, so unfortunately scripts are not forwards/backwards compatible. The top-level scripts provided in the Lochnagar 2 Device Pack use a new WISCE™ feature to check the Lochnagar board identification register and load a different sub-script depending on whether a Lochnagar 1 or Lochnagar 2 board is detected.

The scripts included with the Lochnagar 2 Device Pack use brand new WISCE™ feature to detect whether a Lochnagar 1 or Lochnagar 2 board is connected. This feature allows the top level profile script to read register 0x00 of the Lochnagar device (at I2C address 0x44) and load a different lower level FPGA configuration script depending on whether Lochnagar 1 or Lochnagar 2 is detected. An example is shown below:

```
  * If Lochnagar 1 (ID = 0x50) is present at register 0x00 address 0x44, then load the
spdif_to_cdc_aif1.txt file
  * Otherwise load L2_spdif_to_cdc_aif.txt

  IF 0x00 0x50 SMbus_8_bit_data CHECK 0x44 0xFF
  LOAD spdif_to_cdc_aif1.txt
  ELSE
  LOAD L2_spdif_to_cdc_aif1.txt
  ENDIF
```

This feature was introduced in WISCE™ 3.4.0.19. The profile scripts provided with this Device Pack will generate an error on previous versions of WISCE™, as they do not understand the IF/ELSE syntax.

14.3 Details of Scripts Provided

The scripts provided with the Lochnagar 2 Device Pack are split into two types.

14.3.1 Configuration Template Script

The configuration template file provides a blank template for configuring a full system including both a Lochnagar board and a Smart Codec minicard. It detects whether the system is using a Lochnagar 1 or Lochnagar 2 and allows the user to load a sub-script based upon this detection. The file then provides commented sections to illustrate the normal sequence for setting up registers in a Cirrus Logic Smart Codec.

Note that specific example scripts for setting up particular Smart Codecs are provided along with the WISCE Device Pack for that Smart Codec device.

| Name of Script	Description

Configuration_Template.txt	**Configuration Template for Smart Codec Setup**
	
	This file illustrates the normal sequencing for initialising a Lochnagar based platform with a Cirrus Logic Smart Codec device. The file consists of commented sections which show the generic order of configuration. The file does not contain any register writes to the Smart Codec and is intended to be filled in as a template by the end user.
	
	The sections are:
	
	   1) Lochnagar. This section will call either a Lochnagar 1 or Lochnagar 2 setup script depending on which board is detected. This illustrates how the branching feature of WISCE profile scripts can be used to support both hardware platforms.
	   2) Patch File (if required)
	   3) Clocking config
	   4) Power management (micbias)
	   5) Input enables
	   6) AIF enables
	   7) Mixer setup
	   8) Download DSP
	   9) Output setup
	
	It is not required to fill in all sections. For example, if there is no DSP required in the intended use case, it is not necessary to download any firmware to the DSP cores in section 8.

14.3.2 Lochnagar Setup Scripts

The lower-level Lochnagar 1 and Lochnagar 2 setup scripts are usually loaded by top-level system configuration scripts such as the configuration template, and may be re-used in various Smart Codec use cases. It is intended that the end user use the WISCE plugin to create their own setup scripts for custom use cases if the example scripts do not meet their needs.

Name of Script	Description
L1_spdif_to_cdc_aif1.txt	**Lochnagar 1 configuration script.** *Should only be called when Lochnagar 1 board is detected.* This configures Lochnagar 1 FPGA routing path for S/PDIF tranceiver to AIF1 of the Codec minicard. • Routes S/PDIF MCLK to Codec MCLK1 • Routes PMIC 32k Clock to Codec MCLK2 • Routes S/PDIF audio to Codec AIF1 and return path
L2_spdif_to_cdc_aif1.txt	**Lochnagar 2 configuration script.** *Should only be called when Lochnagar 2 board is detected.* Configures Lochnagar 2 FPGA routing path for S/PDIF transciever to AIF1 of the Codec minicard. • Routes S/PDIF MCLK to Codec MCLK1 • Routes PMIC 32k clock to Codec MCLK2 • Routes S/PDIF audio to Codec AIF1 and return path • Enables S/PDIF transceiver for optical input in hardware control mode
L2_usb_to_cdc_aif1.txt	**Lochnagar 2 configuration script.** *Should only be called when Lochnagar 2 board is detected.* Configures Lochnagar 2 FPGA routing path for USB streaming to AIF1 of the Codec minicard. • Routes USB MCLK In to Codec MCLK1 • Routes PMIC 32k clock to Codec MCLK2 • Routes USB AIF Channels[1-8] audio to Codec AIF1 and return path
L2_usb_to_cdc_aif1_stereo.txt	**Lochnagar 2 configuration script.** *Should only be called when Lochnagar 2 board is detected.* Configures Lochnagar 2 FPGA routing path for USB streaming to AIF1 of the Codec minicard. • Routes USB MCLK In (11/12MHz version) to Codec MCLK1 • Routes PMIC 32k clock to Codec MCLK2 • Routes USB AIF Channels[1-8] audio to TDM/I2S mux • Routes TDM/I2S mux stereo output channels[1-2] to Codec AIF1 • Routes return path from TDM/I2S mux to USB AIF
L2_usb_to_soundcard.txt	**Lochnagar 2 configuration script.** Does not require a codec to be connected. Configures Lochnagar 2 FPGA routing path for USB streaming to Sound Card (3.5 mm jacks on underside) • Routes USB MCLK to SoundCard MCLK • Routes USB AIF Channes[1-8] audio to SoundCard AIF and return path.

15 Troubleshooting

15.1 Lochnagar 2 Drivers in Device Manager

The Lochnagar 2 should appear as a number of devices in the Windows Device Manager.
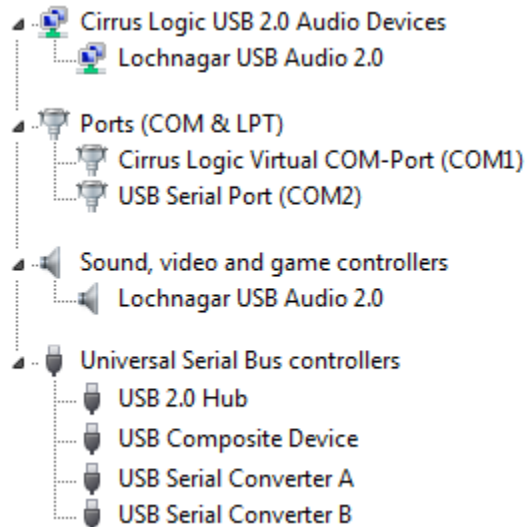
If any of these devices does not appear or appears in the Device Manager with a warning or error notification, the Lochnagar 2 board will not operate correctly.

15.2 Common issues with Lochnagar 2

This section will describe some of the more commonly observed issues with Lochnagar 2 and its drivers, and detail the solutions to these problems.

15.2.1 Audio Driver Issue: Drivers reinstalled while audio playing

If the user installs a new version of the Lochnagar 2 Device Pack while audio is currently playing through the USB audio streaming functionality, the re-installation of the audio drivers can fail. The error message presented by the audio driver installer is quite discreet and easy to miss.

In this scenario, the Lochnagar 2 will present itself in the Device Manager as a USB Composite Device with a warning message that indicates there are no drivers installed for the device.

Problem resolutions:

1. Stop audio playback and close all audio applications. Run the Lochnagar 2 Device Pack installer again and ensure that the audio driver installation is successful. This may also require a full reset of the Windows Operating System.

15.2.2 COM Port Issue: Run out of COM port numbers

Each serial communication port in Windows is allocated with a unique COM port number. There are 256 available COM ports within Windows. Lochnagar 2 requires two separate COM ports: one Virtual COM port for communications with WISCE, and a USB Serial Port that can be used for UART communications with Cirrus devices that support the UART protocol. Windows will attempt to give each device a unique COM port number, so the Lochnagar 2 board will always be allocated the same COM port numbers. These numbers are now effectively allocated to this unique Lochnagar 2 board, and will remain allocated to it even when the board is not currently plugged in. If a different Lochnagar 2 board is plugged into the same system, it will be allocated a different set of COM port numbers.

It is possible for Windows to run out of available COM port numbers. In this instance, it will not be able to allocate COM port to one or both of the Lochnagar 2 COM port devices. In this instance, the affected COM ports will show a warning message in the Device Manager to indicate they are not operating correctly.

Problem resolutions:

1. Open the Device Manager and right-click on the affected COM/Serial Port. Open the Properties dialogue. In the Port Setting tab, click the "Advanced..." button to open another dialogue box. The Advanced Settings menu allows for manual selection of COM port from a drop-down menu. This will show which COM ports are currently available or marked as "(in use)". Choose a COM port number from this list to allocate it to the Lochnagar 2 device. If the new selection is marked as "(in use)", a prompt box will ask for confirmation to continue. If the Lochnagar 2 COM port currently has a COM port assigned to it already, choosing a new COM port number will release its allocation on the old number, so by repeating this step it is possible to free up COM ports that are incorrectly marked as "(in use)".

15.2.3 Lochnagar 2 does not appear in WISCE

This issue can occur even when COM ports have been successfully allocated to both Virtual-COM port and USB Serial Port in the Device Manager.

This can happen if the Lochnagar 2 is unplugged or reset while ASIO audio is playing, or because the Windows COM port driver has encountered some internal error. Usually it is related to unplugging or resetting the Lochnagar 2 board while some aspect (e.g. USB audio streaming or USB serial port terminal communications over UART) are currently in use.

Problem resolutions:

1. Close WISCE, all audio playback applications and any terminal applications currently open on the PC. Reset the Lochnagar 2 board using the S1 (SYSRESET) switch. Re-open WISCE and the Lochnagar 2 board should be present as normal.
2. If the above step does not work, restart the PC as this may correct any errors in the Windows USB driver stack.
3. If the Lochnagar 2 is still not present in WISCE, open the Windows regedit.exe application and find HKEY_LOCAL_MACHINE\HARDWARE\DEVICEMAP\SERIALCOMM. There should be two keys in this list associated with the Lochnagar 2 board: Device\USBSERxxx and Device\VCPx. The COM numbers on these serial ports should match up to the COM numbers observed in the Device Manager. If one of the two COM ports is missing from the registry, Windows has encountered a USB serial driver error. To fix this, go to Device Manager and change the COM port number for the missing device. It should then correctly appear in both the Device Manager and the Registry.

16 Contacting Cirrus Logic Support

For all product questions and inquiries, contact a Cirrus Logic Sales Representative. To find the one nearest you, go to www.cirrus.com.

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