



Off-Ramp 4 User Manual

Empirical Audio Rev. 1.0

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1. Function/Technology

The Off-Ramp 4 is a versatile hi-res compatible USB interface. The function of the Off-Ramp 4 is to convert USB signaling into S/PDIF, AES and I2S so that a DAC can be driven with a computer audio data stream. The Off-Ramp 4 reduces jitter in the digital data stream by re-clocking using local oscillators. The Off-Ramp 4 incorporates our best low-jitter technology and includes an array of technical advantages over other devices on the market, including:

- Async USB, so expensive USB cable is not necessary
- Inputs are re-clocked and S/PDIF and AES outputs are re-clocked again
- External DC power source, allowing battery power
- Separate input and output power regulation
- High-quality discrete voltage regulation with Hynes regulator as option
- Precision impedance-matched high slew-rate S/PDIF and AES/EBU output
- Optimum clocking for best 24/176.4 and 24/192 performance
- I2S output interface for lowest jitter to Empirical Audio DACs
- Modular design to allow for clock, power and USB improvements and upgrades

These technical advantages allow the Off-Ramp 4 to be a world-class digital source, leaving even the most expensive CD transports and USB converters in the dust.

The sound of the Off-Ramp 4 is unlike any other digital source. The clarity and imaging is unsurpassed, allowing you to “see” into the soundstage more than ever before. Width and depth are improved significantly. It is a totally immersive experience, the way that music playback should be. More like vinyl, only better.

1.1. What is jitter?

Jitter is the number one problem limiting the performance of digital audio. Jitter creates an unnatural, harsh and sibilant sound that is pervasive in digital audio. Jitter causes listening fatigue with both CD players and computer audio devices. It's only in the last three years that the audio industry has become sensitive to jitter and started actively addressing this. The sound of jitter is like looking through a window with a film on it. When jitter is reduced, it is like cleaning the window and finally seeing the scenery outside with crystal clarity and vividness.

Jitter is the inaccuracy in the timing of the digital data. It is not data errors, it is inaccuracies in the timing of the presentation of the data to the D/A converter. This is different than sending digital data to a printer for instance, or even a hard-disk. These data transfers are not “real-time”. Streaming audio data from a CD transport or a computer source is real-time because the D/A converter creates a real-time analog signal from the data each time a new data word is presented. If the timing of the presentation of each word is inaccurate, this causes frequency modulation distortion. There is nothing that can be done about the samples in the recording and the clock that was used to make those samples, but playback jitter can be minimized. This is the role of the Off-Ramp 4.

The Off-Ramp 4 virtually eliminates the sibilance and harshness due to jitter, making your digital playback closer to analog. The Off-Ramp 4 is a truly unique and remarkable product. Once jitter is minimized, the clarity, image focus and dynamics are improved significantly. Even bass-tightness improves. Recordings of rain, thunderstorms, violins, cellos, bongos and timpani are finally lifelike.

1.2. Theory of Operation

The primary function of the Off-Ramp 4 is to convert USB streaming audio format into S/PDIF, AES/EBU or I2S formats and provide hardware interfaces in order to be compatible

with DACs. The Off-Ramp 4 is a re-clocker, meaning that the timing of the data flow into the device is retimed using internal clocks. This has nothing to do with the timing or tempo of the music. Because it utilizes an asynchronous USB interface, the master or system clock for your audio system is located in the Off-Ramp 4. This clock provides the timing for the dataflow from the computer source. This is the optimum way to achieve low jitter.

The Off-Ramp 4 reclocker inserts between your computer or USB source and your DAC. The data stream is not modified or upsampled in any way, it only passes through. The only cable that is critical to performance is the cable between the Off-Ramp 4 and your DAC. This should be a high-quality S/PDIF coax, AES/EBU or I2S cable to minimize jitter.

1.3. Performance of different outputs

The three outputs all deliver world-class performance, however in highly resolving systems some differences may be audible.

The I2S output delivers the lowest jitter, for those that have DACs with this type of input. Next best in performance is the S/PDIF or “coax” output. Finally the AES/EBU output is last because it requires an additional buffer to achieve the higher AES voltage spec.

For non-Empirical Audio DACs, we recommend using the S/PDIF output with a high-quality S/PDIF coax cable, such as the Empirical Audio Bitmeister.

1.4. Internal clocks and clock quality

The Off-Ramp 4 comes standard with two clocks or free-running oscillators. Two clocks are required because the asynchronous USB interface uses free-running clocks rather than clocks that are synthesized from a single oscillator frequency. One clock is required for the sample-rate group 44.1/88.2/176.4kHz and a second for the 48/96/192kHz group because the two sample-rate groups are not related.

These clocks can be upgraded, improving the jitter of either one or both of the sample-rate groups. One or two Ultraclocks or one or two Superclock4s can be added. Other clock options may be offered in the future. These clock upgrades are not user-installable.

2. Front-Panel:



- 2.1.1. **Power LED**
Green indicator indicates DC power is applied to the DC input on back-panel.
- 2.1.2. **Data Error**
Yellow indicator indicates that data stream is corrupted or not PCM.
- 2.1.3. **USB Fault**
Red indicator indicates that USB cable is not connected or the USB port at the computer is not active.

3. Back-Panel



3.1. 12VDC Input

This is the power input for the Off-Ramp 4. The power from this input goes directly to the voltage regulators, and any installed Superclocks or Ultraclocks, so the quality of this power is critical. Upgrades here make an immediate difference in jitter. Average power consumption is up to 500ma, depending on clock options, but much higher transient currents are possible. The standard AC adapter included with the Off-Ramp 4 supplies 2.5 Amps @ 12VDC. The connector is center positive, 2.1mm and protected from reverse voltage. To power-on the Off-Ramp 4, plug in the AC adapter and then connect the DC power cable to the Off-Ramp 4. The included AC adapter is floating with respect to the AC power ground, but grounded AC adapters can also be used.

3.2. USB Input

The USB input connects with a standard A-B USB cable to a computer or other streaming USB audio source. The streaming rate limit is 24-bits, 192kHz. The USB interface is asynchronous, so USB 2.0 compliant ports on the computer must be used. The USB cable can be as long as 5 meters or 16 feet. To prevent application and system crashes, it is best to close the music player application, such as iTunes or Foobar **BEFORE** disconnecting the USB cable. Make sure that you load the USB driver into the computer before connecting the USB cable for the first time.

It is recommended that you close your player application (such as Amarra, Pure Music, Foobar etc.), before you unplug the USB cable from the Off-Ramp 4 or computer. Then restart the application after the USB cable is reconnected.

3.3. S/PDIF Coax Output

The S/PDIF coax output (optionally AES/EBU output) is the primary output that will connect to most DACs. The output impedance is 75 ohms. The cable that connects from this connector to your DAC should preferably be of highest quality and match the 75 ohm impedance. The S/PDIF output is transformer-coupled and isolated from earth ground. The RCA jack is made of high-quality direct-gold plated copper with Teflon insulator, so it is better than most BNC connectors. Optionally, a Canare BNC connector can be supplied here, which is also excellent quality. The cable attached to this connector should be at least 1.0m in length, but minimize the length beyond that. 1.5m is usually perfect and will work best with other gear. The internal cable in the Off-Ramp 4 also has 75ohm characteristic impedance.

3.4. AES/EBU Output

The AES/EBU output is on a gold-plated XLR connector. Pin-out is standard pin1-Gnd, pin2 plus or non-inverted signal, pin3 minus or inverted signal. The output impedance between plus and minus conductors is 110 ohms. The output is transformer-coupled. The cable attached to this connector should be at least 1.0m in length, but minimize the length beyond that. 1.5m is usually perfect and will work best with other gear.

3.5. I2S output

I2S is a more direct D/A interface than S/PDIF. It was developed by Philips when Philips and Sony created the CD format and the S/PDIF interface specification. I2S is a three or four-signal interface that includes clocks. All four signals are provided at 3.3V logic levels at the Off-Ramp 4 output, but 5V logic levels are available optionally. I2S is the native interface for most D/A chips. Therefore if one can drive I2S directly and avoid S/PDIF translation, there is the opportunity to reduce jitter even more. Empirical Audio standard I2S interface uses 4 signals and 4 returns and the RJ-45 connector. It is compatible with I2S on several other manufacturers DACs, including Stello, Perpetual Technologies and Northstar, as well as our own Overdrive DAC. Other manufacturers DACs require an adapter cable to make the connection since they don't all use RJ-45 and the pinouts are not compatible. Most of the other manufacturers DACs also require the 5V logic level option. **Make sure the I2S connectors are mated at both ends of the cable before powering-on either the Pace-Car USB or the DAC. Likewise, power both down before disconnecting the I2S cable.**

4. Software

Software drivers must be loaded to support the USB interface for both PC and Mac before connecting the USB cable. For operation on a PC, Kernel Streaming is recommended to bypass Kmixer on XP machines and WASAPI on Vista and Win7 machines.

4.1. USB Drivers

Drivers are located on the included CDROM disk. Load the appropriate driver for your machine and OS and execute it on the computer before powering the Off-Ramp 4 or connecting the USB cable to the computer for the first time.

4.2. Player Software

For PC, the latest version of Foobar2000 is recommended as a player. Install this first. For XP, a Kernel Streaming plug-in is included on the CDROM. Copy this plug-in to the "components" folder under C:\Program Files\Foobar2000. Then start Foobar2000 and select the File pull-down. Then select Preferences. In the Preferences window, go to Playback – Output – select HiFace Kernel Streaming or Empirical Audio async 192.

With XP, the sample-rate will be selected automatically. With Vista and Win7, you must change the sample-rate manually on the computer in control-panel/sounds and audio devices/advanced.

For Mac, we recommend iTunes with software add-ons such as Amarra or Pure Vinyl to improve audio quality and eliminated manual intervention to select sample-rates.

If you use iTunes alone, then select HiFace in Preferences/Audio and use Utilities/Midi options to select the sample-rate. Using iTunes alone requires you to manually select the sample-rate each time you change to playback of a different sample-rate.

5. Quick Start-up

5.1. Mac

- Put the supplied CDROM into your Mac and find the Mac driver folder.
- Open the folder and copy the driver software to your Mac hard disk.
- Execute the driver installation and follow the instructions.
- Power-on the Off-Ramp and connect the USB cable to the Mac and S/PDIF digital coax cable to the DAC.
- Power on the DAC.
- Check in the Preferences/Sounds that you have HiFace or Empirical Audio async 192 selected for output
- Start your music player application
- Check that both the red and yellow LEDs are off on the Off-Ramp
- Play a track or playlist using your player application

5.2. PC

- Put the supplied CDROM into your PC and find the PC driver folder.
- Open the folder and copy the correct driver software to your PC hard disk.
- Execute the driver installation and follow the instructions.
- Power-on the Off-Ramp and connect the USB cable to a USB 2.0 port on your PC and S/PDIF digital coax cable to the DAC.
- Power on the DAC.
- Check in the Control Panel/Sounds and audio devices that you have HiFace or Empirical Audio async 192 selected for output
- Install Kernel Streaming in your player application
- Start your music player application
- Select HiFace Kernel Streaming or Empirical Audio 192 async Kernel Streaming for output
- Check that both the red and yellow LEDs are off on the Off-Ramp

- Play a track or playlist using your player application

6. Specifications

Inputs

1. USB – async 24/192 max sample-rate

Outputs

1. S/PDIF coax
2. AES/EBU
3. I2S on RJ-45, Empirical Audio standard (3.3V or optional 5V)

Jitter specs (cycle to cycle, standard clock):

S/PDIF coax output - <500psec total P-P jitter

I2S Clock outputs - <250psec total P-P jitter

7. Compatibility

The Off-Ramp 4 is designed to work with all DACs and SS receivers/processors. To operate with higher sample-rates, the DAC must support 24-bit operation as well as the higher sample-rate. The I2S output can be converted to 5V optionally for DACs such as Stello or Northstar.

Sample-rates supported: 44.1kHz, 48kHz, 88.2kHz, 96kHz, 176.4kHz, 192kHz

Included

1. Off-Ramp 4 with 2 standard clocks (except with upgraded clocks)
2. 12VDC AC adapter
3. 5m USB cable
4. CDROM with drivers and other software

Options

1. Hynes voltage regulator on USB module
2. Audiocom Superclock4
3. Second Audiocom Superclock4
4. Audiocom Ultraclock
5. Second Ultraclock
6. Monolith LI battery power supply
7. BNC or NextGen output connector rather than RCA
8. 5 Volt I2S output for Northstar and other DACs
9. Revelation Labs Cryo-Silver Reference I2S cable
10. Locus Design Polestar cable - specify length
11. Locus Design Axis cable – specify length
12. Bitmeister S/PDIF coax digital cable – 1.5m recommended