MOTU V4HD™

User's Guide for Mac OS X

MOTU

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SAFETY PRECAUTIONS AND ELECTRICAL REQUIREMENTS

CAUTION! READ THIS SAFETY GUIDE BEFORE YOU BEGIN INSTALLATION OR OPERATION. FAILURE TO COMPLY WITH SAFETY INSTRUCTIONS COULD RESULT IN BODILY INJURY OR EQUIPMENT DAMAGE.

HAZARDOUS VOLAGES: CONTACT MAY CAUSE ELECTRIC SHOCK OR BURN. TURN OFF UNIT BEFORE SERVICING.

WARNING: TO REDUCE THE RISK OF FIRE OR ELECTRICAL SHOCK, DO NOT EXPOSE THIS APPLIANCE TO RAIN OR OTHER MOISTURE.

CAUTION: TO REDUCE THE RISK OF ELECTRICAL SHOCK, DO NOT REMOVE COVER. NO USER-SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.

WARNING: DO NOT PERMIT FINGERS TO TOUCH THE TERMINALS OF PLUGS WHEN INSTALLING OR REMOVING THE PLUG TO OR FROM THE OUTLET.

WARNING: IF NOT PROPERLY GROUNDED THE MOTU V4HD COULD CAUSE AN ELECTRICAL SHOCK.

The MOTU V4HD is equipped with a three-conductor cord and grounding type plug which has a grounding prong, approved by Underwriters' Laboratories and the Canadian Standards Association. This plug requires a mating three-conductor grounded type outlet as shown in Figure A below. If the outlet you are planning to use for the MOTU V4HD is of the two prong type, DO NOT REMOVE OR ALTER THE GROUNDING PRONG IN ANY MANNER. Use an adapter as shown below and always connect the grounding lug to a known ground. It is recommended that you have a qualified electrician replace the TWO prong outlet with a properly grounded THREE prong outlet. An adapter as illustrated below in Figure B is available for connecting plugs to two-prong receptacles.

Figure A

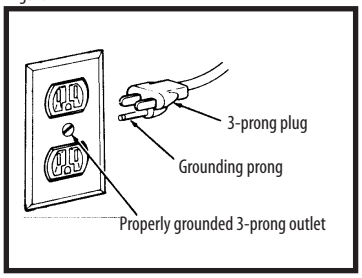
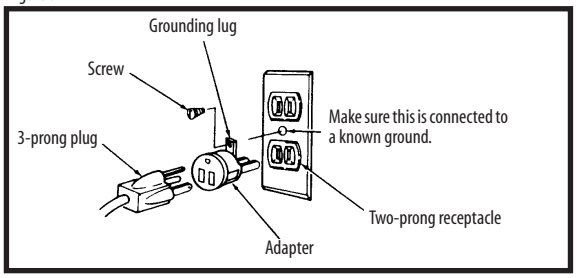


Figure B



WARNING: THE GREEN GROUNDING LUG EXTENDING FROM THE ADAPTER MUST BE CONNECTED TO A PERMANENT GROUND SUCH AS TO A PROPERLY GROUNDED OUTLET BOX. NOT ALL OUTLET BOXES ARE PROPERLY GROUNDED.

If you are not sure that your outlet box is properly grounded, have it checked by a qualified electrician. NOTE: The adapter illustrated is for use only if you already have a properly grounded two-prong receptacle. Adapter is not allowed in Canada by the Canadian Electrical Code. Use only three wire extension cords which have three-prong grounding type plugs and three-prong receptacles which will accept the MOTU V4HD plug.

IMPORTANT SAFEGUARDS

1. Read these instructions. All the safety and operating instructions should be read before operating the V4HD.
2. Keep these instructions. These safety instructions and the V4HD owner's manual should be retained for future reference.
3. Heed all warnings. All warnings on the V4HD and in the owner's manual should be adhered to.
4. Follow all Instructions. All operating and use instructions should be followed.
5. Do not use the V4HD near water.
6. Cleaning - Unplug the V4HD from the computer and clean only with a dry cloth. Do not use liquid or aerosol cleaners.
7. Ventilation - Do not block any ventilation openings. Install in accordance with the manufacturer's instructions.
8. Heat - Do not install the V4HD near any heat sources such as radiators, heat registers, stoves, or another apparatus (including an amplifier) that produces heat.
9. Overloading - Do not overload wall outlets and extension cords as this can result in a risk of fire or electrical shock.
10. Grounding - Do not defeat the safety purpose of the polarized or grounding-type plug. A polarized plug has two blades with one wider than the other. A grounding-type plug has two blades and a third grounding prong. The wide blade or the third prong are provided for your safety. If the provided plug does not fit into your outlet, consult and electrician for replacement of the obsolete outlet.
11. Power cord - Protect the V4HD power cord from being walked on or pinched by items placed upon or against them. Pay particular attention to cords and plugs, convenience receptacles, and the point where they exit from the V4HD.
12. Power switch - Install the V4HD so that the power switch can be accessed and operated at all times.
13. Disconnect - The main plug is considered to be the disconnect device for the V4HD and shall remain readily operable.
14. Accessories - Only use attachments/accessories specified by the manufacturer.
15. Placement - Use only with the cart, stand, tripod, bracket or table specified by the manufacturer, or sold with the V4HD. When a cart is used, use caution when moving the cart/apparatus combination to avoid injury from tip-over.
16. Surge protection - Unplug the V4HD during lightning storms or when unused for long periods of time.
17. Servicing - Refer all servicing to qualified service personnel. Servicing is required when the V4HD has been damaged in any way, such as when a power-supply cord or plug is damaged, liquid has been spilled or objects have fallen into the V4HD, the V4HD has been exposed to rain or moisture, does not operate normally, or has been dropped.
18. Power Sources - Refer to the manufacturer's operating instructions for power requirements. Be advised that different operating voltages may require the use of a different line cord and/or attachment plug.
19. Installation - Do not install the V4HD in an unventilated rack, or directly above heat-producing equipment such as power amplifiers. Observe the maximum ambient operating temperature listed below.
20. Power amplifiers- Never attach audio power amplifier outputs directly to any of the unit's connectors.
21. Replacement Parts - When replacement parts are required, be sure the service technician has used replacement parts specified by the manufacturer or have the same characteristics as the original part. Unauthorized substitutions may result in fire, electric shock or other hazards.
22. Safety Check - Upon completion of any service or repairs to this MOTU V4HD, ask the service technician to perform safety checks to determine that the product is in safe operating conditions.

ENVIRONMENT

Operating Temperature: 10°C to 40°C (50°F to 104°)

TO REDUCE THE RISK OF ELECTRICAL SHOCK OR FIRE

CAUTION
RISK OF ELECTRIC SHOCK
DO NOT OPEN

Do not handle the power cord with wet hands. Do not pull on the power cord when disconnecting it from an AC wall outlet. Grasp it by the plug. Do not expose this apparatus to rain or moisture. Do not place objects containing liquids on it.

AC INPUT

100 - 240VAC ~ • 50 / 60Hz • 45 Watts.

Contents

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This equipment has been type tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications or television reception. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television equipment reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by any combination of the following measures:

- Relocate or re-orient the receiving antenna
- Increase the separation between the equipment and the receiver
- Plug the equipment into an outlet on a circuit different from that to which the receiver is connected

If necessary, consult a dealer or experienced radio/television technician for additional assistance.

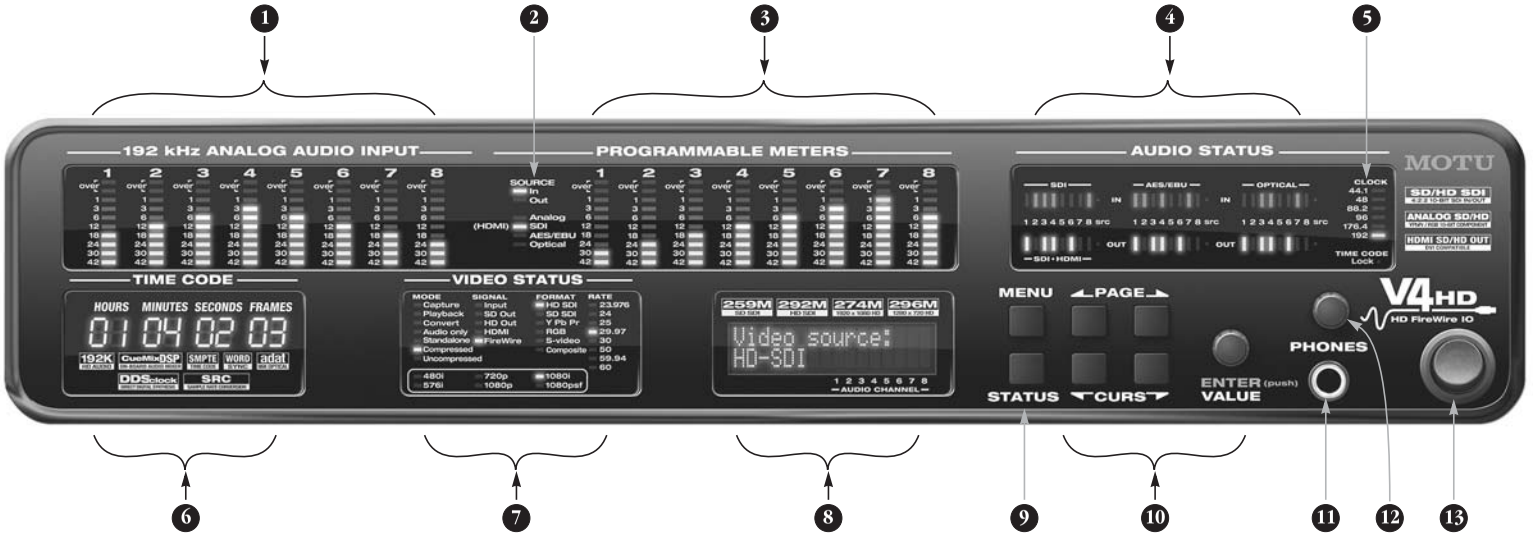
PLEASE NOTE: only equipment certified to comply with Class A (computer input/output devices, terminals, printers, etc.) should be attached to this equipment, and it must have shielded interface cables in order to comply with the Class A FCC limits on RF emissions.

WARNING: changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

CE

Part 1
Getting Started

Quick Reference: V4HD Front Panel



1. These 10-segment level meters are dedicated to the V4HD's eight analog audio inputs. The top red 'over' LED illuminates when the signal reaches full scale—for even just one sample. The second 'over' LED below only illuminates momentarily so that you can continue to adjust level even after clipping has just occurred.

2. The light that is illuminated here tells you which 8-channel audio bank (analog, AES/EBU, optical or embedded) you are monitoring with the programmable meter bank to the right. You can monitor input or output for any bank. Use the LCD or software to choose the desired bank.

3. This bank of level meters can be programmed (via the LCD or software) to display one of four different banks: analog, AES/EBU, optical or embedded. The LEDs to the left show which bank you are currently monitoring.

4. Internally, the V4HD is divided into four 8-channel banks of audio I/O: analog, AES/EBU, optical and embedded (SDI or HDMI). This section shows input and output activity for the three digital banks. The SRC light indicates that sample rate conversion is being applied to an input or output bank.

5. The CLOCK LEDs indicate the global audio sample rate at which the V4HD is operating. Use the MOTU Audio Setup software to set the sample rate or to choose an external clock source, from which the sample rate will be set. When no sample clock is currently present, these lights flash. For example, if you've set the V4HD to slave to an external clock, such as AES/EBU, but there is no clock signal currently being detected, these lights will flash. The Time Code Lock LED illuminates when the V4HD is converting time code.

6. The Time Code Display rolls whenever the V4HD is converting time code, either from the time code input or perhaps from SDI-embedded time code. It also rolls during playback from host software (Final Cut Pro) and reflects the position of the play head on the time line.

7. The VIDEO STATUS section provides quick feedback regarding the V4HD's current video operation. Repeatedly press the STATUS button (9) to cycle through the various modes. See "Video Status" on page 96 for details.

8. The V4HD LCD provides direct access to most of its settings. Repeatedly press the MENU button (9) to cycle through the main menus, and then use the PAGE and CURSOR buttons, along with the VALUE/ENTER knob, to choose and make settings. For complete details, see "Multi-Function LCD display" on page 97.

9. Repeatedly press the MENU button to cycle through the main menus in the programmable LCD. Repeatedly press the STATUS button to cycle through the various video status modes in the VIDEO STATUS section.

10. Use these buttons and knob to navigate the settings in the programmable LCD. For complete details, see "Multi-Function LCD display" on page 97.

11. This is a standard quarter-inch stereo headphone jack. From the factory, its output matches analog outputs 1-2 on the rear panel. But it can be programmed to mirror any other output pair. Use the volume knob above to control its level.

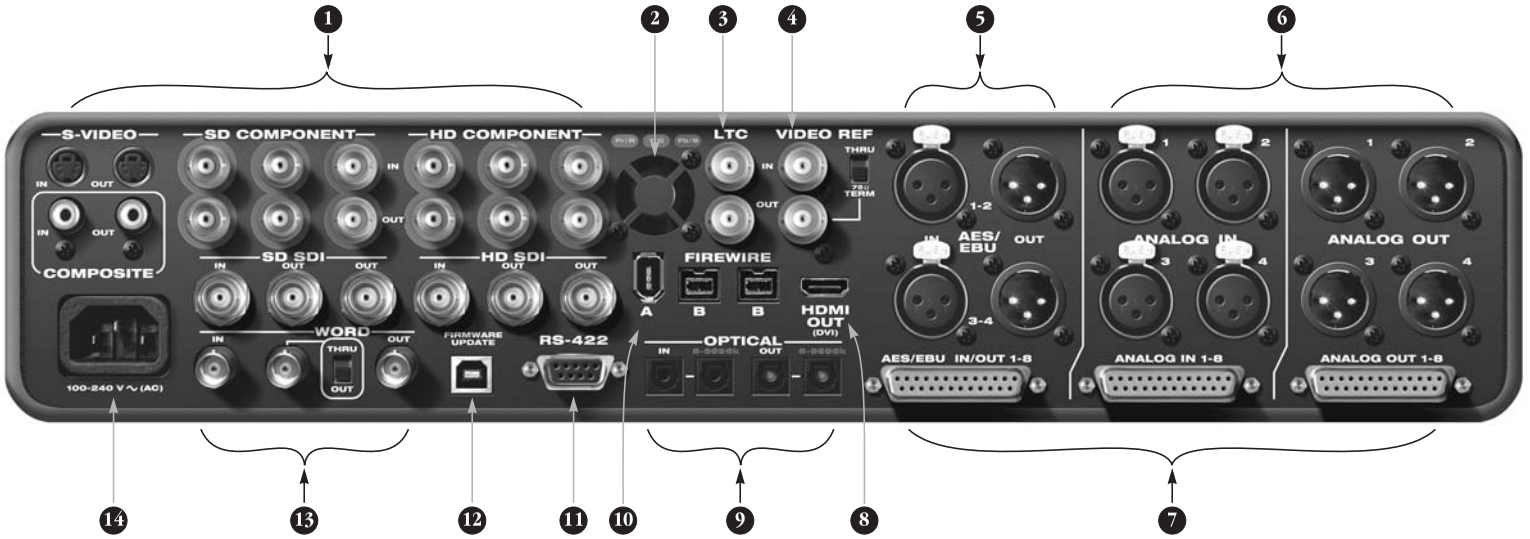
12. The PHONES knob is a rotary encoder that can be pushed as well as turned:

    - Turn it to adjust headphone volume. The LCD provides temporary feedback for the headphone level as you turn the knob.

    - Push in the knob (so that it clicks) and then turn it to adjust the volume of the analog outputs 1-2. Again, the LCD provides temporary feedback as you turn. By default, the knob controls analog outputs 1-2, but you can program the knob (via the LCD) to control any combination of the V4HD's 32 outputs.

13. FireWire is a "plug-and-play" protocol. That means that you can turn off the V4HD and turn it back on (or even unplug it) without restarting your computer. Keep in mind, however, that if you wish to change the V4HD's settings with the console software, the V4HD needs to be plugged in and switched on.

Quick Reference: V4HD Rear Panel



1. The analog video I/O section of the V4HD is equipped with 12-bit converters that deliver 10-bit capture and playback, with support for both RGB or YPbPr color space. Once you've connected your SD and HD video device(s) to the appropriate jacks, you can choose any input (analog or digital) as a source (from the LCD or software console) and the V4HD converts to all SD and HD output formats simultaneously, including the digital outputs discussed below.

2. The V4HD is packed full of state-of-the-art technology mounted on no less than six separate circuit boards. It gets hot in there. Be sure to leave plenty of room for the fan to move air through the V4HD enclosure. Try to avoid placing the V4HD above other heat sources.

3. Connect time code input and output here, to the LTC IN and LTC OUT. The V4HD supports all standard time code formats.

4. Connect blackburst or another video reference to the VIDEO REF IN. If the V4HD is at the end of the video sync daisy chain, flip the THRU/TERM switch to the *75Ω TERM* position. If you are daisy-chaining another device, flip it to THRU. This jack also supports HD Tri-level sync.

5. If you only need 2 or 4 channels of AES/EBU digital audio I/O, connect them to these XLR jacks. If you need 8 channels, connect a breakout cable to the DB25 connector below.

6. If you only need 1 to 4 channels of analog audio input and output, connect them to these 4 XLR input and output jacks. If you need 8 channels, connect a breakout cable to the DB25 connectors below. These analog inputs and outputs are equipped with 24-bit converters that support sample rates from 44.1 kHz up to 192kHz.

7. If you need more than 4 channels of AES/EBU input/output and/or analog input/output, connect an 8-channel DB25 to XLR breakout cable to these DB25 connectors. When you do so, the rear panel XLR jacks become disabled. In other words, you can use either the XLRs or the breakout, but not both at the same time (8 channels maximum for each bank).

8. Connect a plasma, LCD, DLP or other HDMI-equipped monitor here. Alternately, you can connect a DVI-equipped device with an adapter cable. The V4HD supports 8-channel PCM (uncompressed) embedded audio over HDMI, so you could also connect this output to an HDMI-equipped home theater receiver to deliver both picture and multi-channel audio.

9. The two ADAT optical ("lightpipe") ports labeled IN/OUT provide 8 channels of digital audio input and output at 44.1 and 48 kHz. At the 2x sample rates (88.2 or 96 kHz), they provide channels 1-4 (in and out) and the second set (labeled in blue) provides channels 5-8 (in and out). When operating the optical ports at a 2x sample rate, be sure to choose either Type I or Type II operation, as explained in "ADAT Type" on page 99.

10. Connect the V4HD to the computer here using any standard FireWire A (1394a) or FireWire B (1394b) cable. If you plan to use Apple ProRes 422 HQ (High Quality) as your HD codec of choice in Final Cut, you must use FireWire B. If you plan to use DVCProHD, or if you are working in SD (any supported format), you can use either FireWire A or B: it doesn't matter. You can use the two FireWire B ports to daisy-chain the V4HD and other FireWire 800 devices to the computer, with the computer serving as the Firewire host. But be careful not to overload the FireWire bus with too much I/O bandwidth.

11. For 9-pin machine control over an RS-422 equipped device, such as a VTR or camera, connect it here. This allows you to control the transport of the device from Final Cut Pro and use features such as Batch Capture and Edit to Tape.

12. In the event that a firmware update becomes available for the V4HD, you would connect this USB port to your computer and then use software to download the new firmware into the V4HD hardware.

13. Make audio WORD CLOCK connections here. The V4HD supports word clock sample rates up to 192kHz. If you need to daisy chain another word clock-equipped device from the V4HD, connect it to the middle BNC connector and flip the THRU/OUT switch to THRU.

14. The V4HD has an internal, international, auto-switching power supply. Connect any AC power source from 100V to 240V.

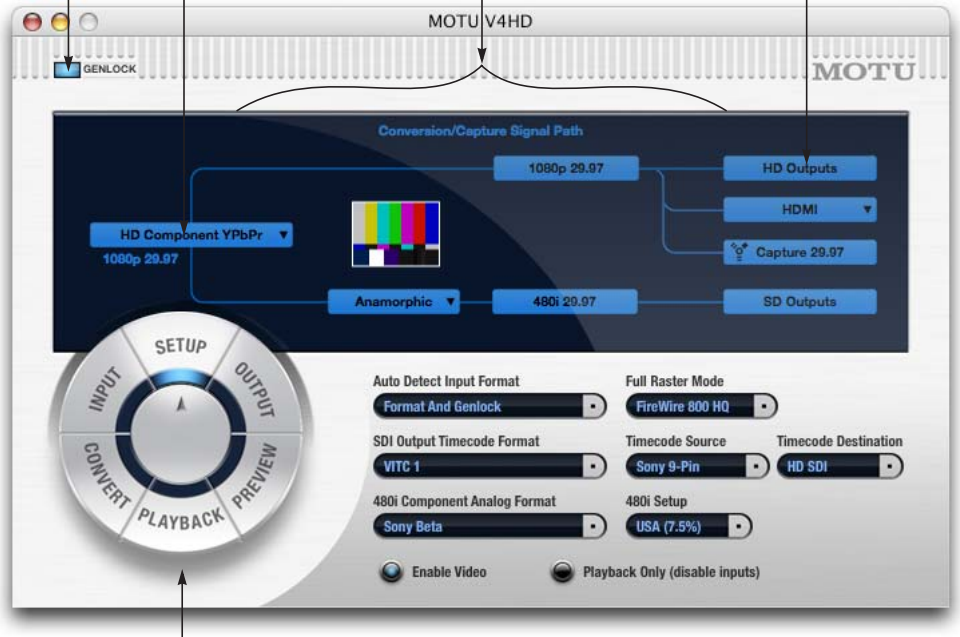
Quick Reference: MOTU Video Setup

This is the video source menu. The V4HD has two video modes: In *Capture/Convert* mode, use this menu to choose the source video input on the V4HD's rear panel. This is the input that the V4HD routes to all outputs and the computer. In *Playback* mode, the Signal Path Diagram displays the playback signal path (from the computer to the V4HD outputs).

This column shows the various HD and SD destinations, including HD and SD outputs on the V4HD itself, the HDMI output (which can alternately be used for DVI output), and FireWire Capture (in Final Cut Pro).

Indicates when the V4HD has successfully achieved lockup to the currently selected input or, in Playback mode, clock source, which could be the V4HD's internal clock or the video REF IN jack.

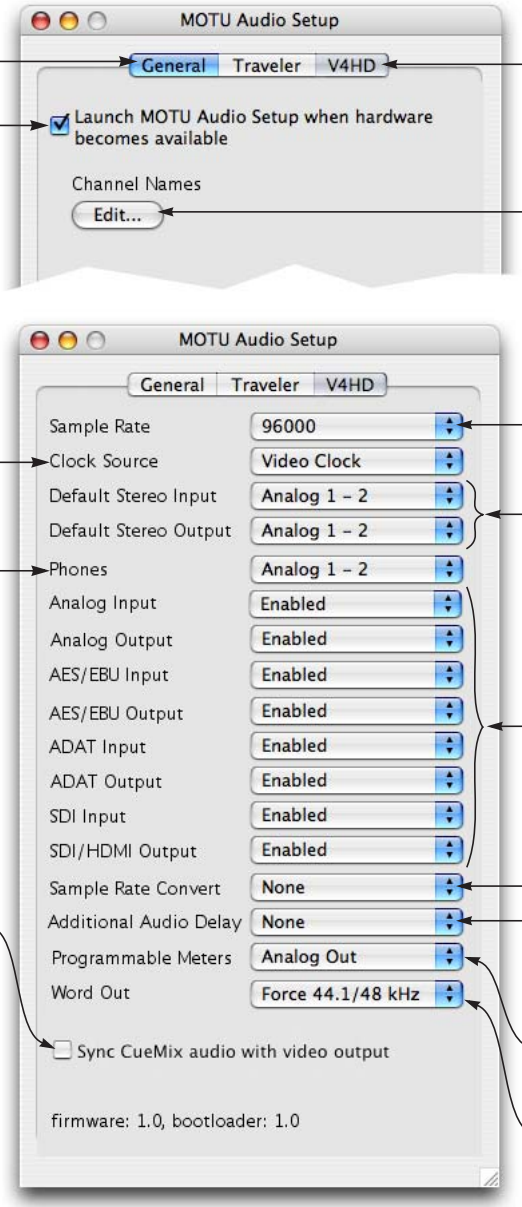
This area of MOTU Video Console provides a signal path diagram (from left to right) for Playback mode or Capture/Convert mode. The upper path shows HD output and the lower path shows SD output. As indicated by arrows, some items are menus from which you can choose settings.



Click a tab to view its settings to the right. The SETUP tab has global settings, such as the *Playback Only* mode button. For complete details on the settings in these tabs, see chapter 6, "MOTU Video Setup" (page 41).

Click a tab on the left to view its settings here.

Quick Reference: MOTU Audio Setup



Click the General tab to access these settings.

Check this option if you would like the MOTU Audio Setup icon to appear in the application dock as soon as a MOTU interface is detected (switched on, plugged in, etc.)

If the video features of the V4HD are enabled (see "Enable Video" on page 50), the only choice in the Clock Source menu is *Video Clock*, and audio always remains resolved to video. When the V4HD is in *Audio Only* mode, this clock source setting determines the clock source for your V4HD while it operates as an audio interface. If no digital audio devices are connected, set this to *Internal*. The other settings are for digital transfers (via AES/EBU or optical) or external synchronization to other systems.

This menu lets you choose what you will hear from the headphone jack.

The V4HD has a built-in 32-channel, 16-bus monitor mixer called CueMix. This option automatically ensures that live audio input patched through CueMix remains in sync with the V4HD's video output. For example, if there is video conversion delay, CueMix will also be delayed to match it.

Click the tabs to access general MOTU interface settings or settings specific to the V4HD (or other connected interface, such as the Traveler, as shown here.)

This button opens another dialog that lets you assign your own customized names to each V4HD input and output. For example, if you have a camera plugged into inputs 1-2, you could name it *Camera Input*. Your customized names then appear in your host audio application (if it supports Core Audio input naming).

Choose the global sample rate for the system here.

Specifies the stereo input and output pair when the V4HD is chosen for Mac OS X audio I/O.

These menus let you individually enable or disable the V4HD's eight 8-channel audio input and output banks. Disabling unused banks helps conserve FireWire bus bandwidth. For details, see "V4HD tab Settings" on page 73.

Engages sample rate conversion on the digital input or output bank that you choose. See "Sample rate conversion" on page 31.

Adds delay during playback from Final Cut so you can align audio with connected monitors that have inherent video delay.

Lets you choose the audio bank you wish to see on the bank of front panel programmable meters.

Word clock output can either match the current V4HD system clock (up to 192kHz) or you can force it to output the corresponding 1x rate (either 44.1 or 48kHz).

MOTU Audio Setup appears in the dock when you launch it. If the *Launch MOTU Audio Setup when hardware becomes available* option is checked (as shown above), the icon appears as soon as you switch on your V4HD interface. If you click and hold on the dock icon (instead of clicking it) or control-click, you can directly access settings, as shown to the left.

CHAPTER 1 About the V4HD

OVERVIEW

The V4HD is a FireWire video interface that can operate in two modes: as a video capture and playback device for a Mac or as a stand-alone video converter/distribution hub.

As a video interface, the V4HD connects directly to a computer via a standard FireWire cable and turns a Mac desktop or laptop computer into a powerful HD/SD video production workstation equipped with all the video and audio I/O needed to produce broadcast quality HD and SD video material.

In Final Cut Pro, the V4HD supports full-raster 1920 x 1080 HD capture and playback using Apple's ProRes 422 codec in both standard and HQ modes. The V4HD is the ideal all-in-one video capture solution for any ProRes workflow.

TheV4HD also provides hardware-accelerated capture and playback of DVCProHD, DVCPro50 and DVCPro25 video streams, plus 8- and 10-bit uncompressed SD — all with convenient plug-and-play FireWire connectivity and CPU-efficient intra-frame editing.

The V4HD is ideal for a DVCProHD/P2 workflow because you can immediately play back P2 clips (either imported or ingested) with no transcoding necessary. Conversely, you can connect any SD or HD video source such as an HDV camera, legacy video deck or DVD player and then capture it directly as a DVCProHD clip in Final Cut. Many cameras now feed their uncompressed SDI or component output directly from the camera's optics and image sensor, before compression, for the best-possible picture quality during capture with the V4HD.

The V4HD provides hardware-accelerated SD-to-HD up conversion for capturing SD sources in ProRes or DVCProHD format. It also provides hardware-accelerated HD-to-SD down conversion.

When the V4HD is not connected to a computer via FireWire, it operates as stand-alone video converter/distribution hub, or as a stand-alone audio mixer.

A wide range of video equipment can be connected to the V4HD, from legacy SD camcorders and CRT monitors to the latest HD cameras, video decks, LCD reference monitors and plasmas — all at the same time, with no cable swapping.

In all modes, the V4HD dynamically converts the currently chosen input source to all outputs simultaneously. This allows you to connect all of your HD and SD gear, choose any source from your computer desktop and then monitor the source material in multiple formats simultaneously as you convert and capture. You can even monitor material in both HD and SD simultaneously with hardware-accelerated up/down conversion with pull-down insertion or removal.

The V4HD provides advanced synchronization and machine control features, including support for time code, 9-pin machine control, video reference and audio word clock. For audio synchronization, the V4HD employs Direct Digital Synthesis (DDS), a DSP-driven phase lock engine that delivers fast lockup times and sub-frame accuracy.

The V4HD is housed in a rugged aluminum alloy chassis with a standard 19-inch, two-space, rack-mountable form factor. Included rack mounting brackets can easily be removed for convenient desktop operation.

The V4HD is designed to streamline your video production workflow, with unified control over all your video gear from the convenience of your computer desktop.

FEATURE HIGHLIGHTS

- HD/SD FireWire video interface — provides HD and SD capture and playback for any current-generation FireWire equipped computer.
- Plug-and-play connectivity via FireWire 400 or 800 — connects to either a desktop tower or a portable laptop.
- Supports Apple Final Cut Pro (Mac) and Adobe Premiere Pro (Windows).
- Captures and plays all standard HD and SD formats up to and including 1080p30 (720p, 1080i, 1080p and 1080PsF).
- Full-raster Apple ProRes workflow — supports full-raster capture and playback (1920 x 1080 and 1280 x 720) in Apple's ProRes 422 HD codec in both standard and HQ modes. Work with ProRes clips pixel for pixel in full 10-bit 4:2:2 resolution.
- Hardware-accelerated DVCPro capture/playback — provides hardware-accelerated capture and playback of industry standard DVCProHD/P2, DVCPro50 and DVCPro25 video streams to/from Final Cut Pro.
- Pristine HD quality and efficient editing — ProRes and DVCProHD formats provide 10-bit 4:2:2 broadcast quality color and CPU-efficient, intra-frame native editing.
- Captures and plays uncompressed SD — 8-bit or 10-bit NTSC or PAL.
- HDMI monitoring — connect a large-format HD plasma, reference LCD, consumer DLP or other flatscreen for flexible and affordable "pixel for pixel" HD monitoring.
- Broadcast quality hardware-based real time SD-to-HD up-convert — capture SD while working in HD; monitor HD when working in SD.
- Broadcast quality hardware-based real time HD-to-SD down-convert — capture HD while working in SD; monitor SD when working in HD.
- Hardware-accelerated 2:3 or 2:3:3:2 pull-down insertion and removal — go between film and NTSC rates in real time, with no rendering required.
- Comprehensive up/down conversion formatting — anamorphic, pillar box, letterbox, 14:9 pillarbox, 14:9 letterbox and full screen.
- Simultaneous HD/SD operation — connect multiple HD and SD sources and destinations simultaneously. Switch HD/SD sources on the fly while converting to multiple HD/SD destinations. All outputs are "hot", regardless of source format.
- Two rack space form factor with dedicated connectors — no cable swapping or gangly, inconvenient breakout cables.
- Stand-alone operation — converts and distributes selected input source to all supported output formats with SD-to-HD up-convert, HD-to-SD down-convert and pull-down insertion/removal.

VIDEO I/O

- 1 x HD-SDI in and out (4:2:2 10-bit) on independent BNC connectors
- 1 x SD-SDI in and out (4:2:2 10-bit) on independent BNC connectors
- 1 x extra HD-SDI output connector
- 1 x extra SD-SDI output connector

- 1 x HDMI output (4:2:2 10-bit, YCbCr or RGB)
- Support for DVI output with HDMI-to-DVI adapter (sold separately)
- 1 x HD component in and out (10-bit, YPbPr or RGB) on independent BNCs
- 1 x SD component in and out (10-bit, YPbPr or RGB) on independent BNCs
- 1 x composite in and out (10-bit)
- 1 x S-video in and out (10-bit)
- 12-bit A/D and D/A converters on all analog video in/out with up to 8x oversampling

VIDEO FORMATS

- SD — 576i25 (PAL), 480i29.97 and 486i29.97 (NTSC)
- HD — 720p23.976, 720p24, 720p25, 720p29.97, 720p30, 720p50, 720p59.94, 720p60, 1080p23.976, 1080p24, 1080p25, 1080p29.97, 1080p30, 1080PsF23.976, 1080PsF24, 1080PsF25, 1080PsF29.97, 1080PsF30, 1080i25, 1080i29.97, 1080i30
- Supported Final Cut Pro HD formats — Apple ProRes or DVCProHD 720p at all eight frame rates listed above, plus full-raster (1920 x 1080) ProRes or DVCProHD 1080 (1280 and 1440 rasters) at all 1080 frame rates listed above
- Supported Final Cut SD formats — Uncompressed 8-bit and 10-bit, DVCPro and DVCPro 50 at 480p23.976, 480i29.97 and 576i25
- 480p23.976 SD capture and playback with hardware pull-down insertion/removal

AUDIO I/O

- 32 channels of simultaneous audio input and output
- 8 channels of analog in/out at all standard sample rates from 44.1 to 192kHz
- 4 x XLR analog in/out — 4-channel direct connection without a breakout cable
- 8 channels of AES/EBU digital in/out at sample rates up to 96kHz
- 2 x AES/EBU connectors — 4-channel direct connection without a breakout cable
- 8-channel HD-SDI and SD-SDI embedded audio in/out, 24-bit at 44.1 or 48kHz
- 8-channel HDMI embedded audio output, 24-bit at 44.1 or 48kHz
- Embeds SDI and HDMI multi-channel audio streams; de-embeds SDI audio input
- 8-channel ADAT optical digital audio in/out — includes a second bank of optical connectors for 8-channel operation at sample rates up to 96kHz
- Flexible 8-channel sample rate conversion — apply rate conversion to any 8-channel digital input or output bank, including AES/EBU, embedded and optical
- Front panel headphone jack with dedicated volume control
- Programmable front panel volume control for up to 32 audio outputs — control output level for any/all outputs, from stereo main outs to 7.1 surround to all 32 outs
- CueMix FX built-in monitor mixer — 32-channel, 16-bus mixer for monitoring live inputs from cameras, mic preamps or other audio sources with virtually no delay.
- Set up send/return loops to digital mixers and outboard audio processing.
- Multiple CueMix FX mixes — create 16 separate stereo monitor mixes (4 stereo at 176.4 or 192kHz) for main outs, headphones, outboard gear send/return loops, etc.

- Audio delay compensation — both fully automated and programmable controls ensure that audio always remains perfectly in sync with picture

- Audio only mode — operates as a 24 channel cross-platform audio interface

- Stand-alone operation — mix and monitor with no computer connected

SYNC AND DEVICE CONTROL

- Video reference in and thru — resolve to blackburst, composite or HD Tri-level sync

- Time code in and out — generate and resolve to time code (LTC, SD VITC or embedded)

- RS-422 machine control — control the transports of a connected camera or video deck using Final Cut Pro or other machine control host via standard 9-pin protocol

- Word clock in, out and thru — continuously resolve to audio word clock from a digital mixer, distribution box or other source at sample rates from 44.1 to 192K

- Direct Digital Synthesis — DSP-driven phase lock engine provides ultra-low jitter

- Field upgradable firmware via USB

FRONT PANEL PROGRAMMING AND MONITORING

- Access to most settings directly from the front panel backlit LCD

- 8 dedicated 10-segment ladder LEDs with clip indicators for all 8 analog audio ins

- 8 programmable 10-segment ladder LEDs with clip indicators for displaying any 8-channel bank (analog, AES/EBU, optical or embedded) in or out

- Video status LEDs — quick access to capture/playback settings for each video format

- Time code display — provides frame-accurate time code readout when converting or generating time code, or during playback from host software

POWER

- International auto-switching internal power supply

INCLUDED SOFTWARE AND COMPATIBILITY

- Includes MOTU Video Setup software — graphically displays HD and SD signal path and provides complete control of all programmable features and settings

- Includes CueMix FX software — provides on-screen mixing of all 32 audio channels of analog and digital audio input and output via graphic mixer with 32 faders

- Supports Final Cut Pro 5.1 or later

CHAPTER 2 Packing List and Mac System Requirements

PACKING LIST

The V4HD ships with the items listed below. If any of these items are not present in your V4HD box when you first open it, please immediately contact your dealer or MOTU.

- One V4HD with removable rack ears
- One FireWire 400 cable
- One FireWire 800 cable
- One power cord
- One V4HD Mac/Windows manual
- One software installer CD
- Product registration card

MAC SYSTEM REQUIREMENTS

The V4HD system requires the following Mac system:

- A G5 Power Mac or faster equipped with at least one FireWire port; a multi-processor Intel Mac is recommended
- At least 1 GB (gigabyte) of RAM (2 GB or more is recommended)
- Mac OS X (version 10.4.9 or later)
- A large hard drive (preferably at least 500 GB)

PLEASE REGISTER TODAY!

Please register your V4HD today. There are two ways to register.

- Visit www.motu.com/registration to register online

OR

- Fill out and mail the included product registration card

As a registered user, you will be eligible to receive technical support and announcements about product enhancements as soon as they become available. Only registered users receive these special update notices, so please register today.

Thank you for taking the time to register your new MOTU products!

CHAPTER 3 Installing the V4HD Hardware

OVERVIEW

Here's an overview for installing the V4HD:

SD AND HD VIDEO OVER FIREWIRE

The V4HD connects to your computer via a single FireWire connection. Two FireWire formats are provided on the V4HD rear panel:

FireWire format	Technical name	Bit rate
FireWire A	IEEE 1394a	400 Mb/sec
FireWire B	IEEE 1394b	800 Mb/sec

FireWire A operates at 400 Megabits per second (Mb/sec) and FireWire B operates at 800 Mb/sec. If you are working with uncompressed SD or any form of DVCPro, you can use either FireWire A (400) or B (800). If you are working with Apple ProRes 422, especially in HQ (High Quality) mode, you should use FireWire B (800) for best results. If you are working with Apple ProRes 422 in standard mode, you can use FireWire A or B. For further details about working with ProRes (and other codecs), see "Choosing a workflow" on page 59.

Daisy-chaining FireWire devices

With the exception of ProRes HQ, FireWire A provides enough bandwidth for the V4HD to operate by itself. FireWire A does not, however, provide enough bandwidth for additional devices connected to the same bus. So if you connect the V4HD to the computer via FireWire A, do not daisy-chain other devices to its FireWire bus.

If you are working with Apple ProRes and the V4HD's full raster mode via FireWire B, it is best not to daisy-chain other FireWire devices on the same bus, as this could cause bus bandwidth conflicts and performance issues.

If you are working with uncompressed SD or DVCPro, FireWire B has enough bandwidth to allow for the possibility of a second device to share the bus with the V4HD, which at most requires approximately half of the bus. However, caution is advised. Performance will depend on how much maximum bandwidth the other device requires, either sustained bandwidth or in bursts. If you have a very high-performance FireWire B hard drive, for example, you will likely be better off connecting it to a separate FireWire bus, either supplied by the motherboard of your computer or by a 3rd-party add-on PCI card adaptor.

Multiple FireWire ports

If your computer supplies multiple FireWire ports, that doesn't necessarily mean they operate on completely separate FireWire busses. In fact, chances are good that they share the same bus, even FireWire A and B ports. The final generation of PowerPC G5 computers, along with all current generation Intel-based Macs (Mac Pro, MacBook, MacBook Pro, etc.), provide multiple FireWire ports in both FireWire A and B formats, but in each

case, all ports (both A and B) share the same internal FireWire bus. So plan accordingly for your FireWire resources. In addition, keep in mind that if you connect a FireWire A device, it can slow the entire bus to whenever the device is active on the bus, so any connected FireWire B devices may not be able to operate at their full performance levels at all times. (If the FireWire A device is not active, however, it won't affect the bus.)

FireWire is for computer connection only

The V4HD does not serve as a FireWire host: it only operates as a FireWire client to a host computer. This means that you cannot connect cameras, hard drives or other client FireWire devices to the V4HD when it is operating as a stand-alone converter (with no computer connected). When the V4HD is operating in stand-alone mode, the only way to connect a camera to the V4HD is through the standard video connectors (analog, SDI, etc.) For more information about stand-alone operation, see chapter 11, "Standalone Operation" (page 93).

CONNECT THE V4HD TO YOUR COMPUTER

1 Plug one end of the V4HD FireWire cable into the FireWire socket on the computer as shown below in Figure 3-1. If you plan to use Apple's ProRes HQ (High Quality) codec with Final Cut Pro, you must use the FireWire B connection.

2 Plug the other end of the FireWire cable into the V4HD I/O as shown below in Figure 3-1.

Figure 3-1: Connecting the V4HD to the computer.

☛ Only make ONE FireWire connection to the computer: either FireWire A or B, but NOT both.

CONNECT VIDEO INPUTS AND OUTPUTS

The V4HD provides a wealth of video input and output connectivity, from consumer analog formats such as S-video and composite to broadcast formats such as HD-SDI. Internally, the V4HD has been designed to support all video input and output simultaneously, allowing you to choose any input as the current source signal while the V4HD simultaneously converts that signal to all output formats, including real-time encoding for transfer over FireWire to the computer for capture in Final Cut Pro.

Keep this in mind as you make your video connections. For example, you can connect both SD and HD gear to their respective inputs and outputs during installation, and simply choose among them from your computer desktop during routine operation. In the case of the SD- and HD-SDI connectors, two outputs are provided, allowing you to connect four SDI destinations (two SD and two HD) that share the same output signal.

Support for both NTSC and PAL

The V4HD supports both NTSC and PAL formats on all inputs and outputs. It does not, however, convert between NTSC and PAL. Instead, it operates all inputs and outputs in one format or the other, as determined by the chosen video source. For details about choosing a video source, see "Video Source menu" on page 44.

S-video (Y/C)

Connect any S-video source or destination, including consumer or prosumer camcorders, desktop video converters, VTRs, or monitors. For best results, use standard, high-quality shielded 4-pin mini-DIN S-video cables. You can connect the same device to both the input and output, or you can connect two separate devices (one to the input and the other to the output).

Composite

Connect any composite source or destination, including consumer or prosumer camcorders, desktop video converters, VTRs, or monitors. For best results, use standard, high-quality shielded video RCA cables. You can connect the same device to both the input and output, or you can connect two separate devices (one to the input and the other to the output).

Component

The component video section provides simultaneous connection to both HD and SD component inputs and outputs. The V4HD provides 10-bit analog performance with 12-bit A/D and D/A converters. In general, component video signals tend to be higher quality than composite or S-video, so to take full advantage of the component format, be sure to use high quality shielded BNC cables.

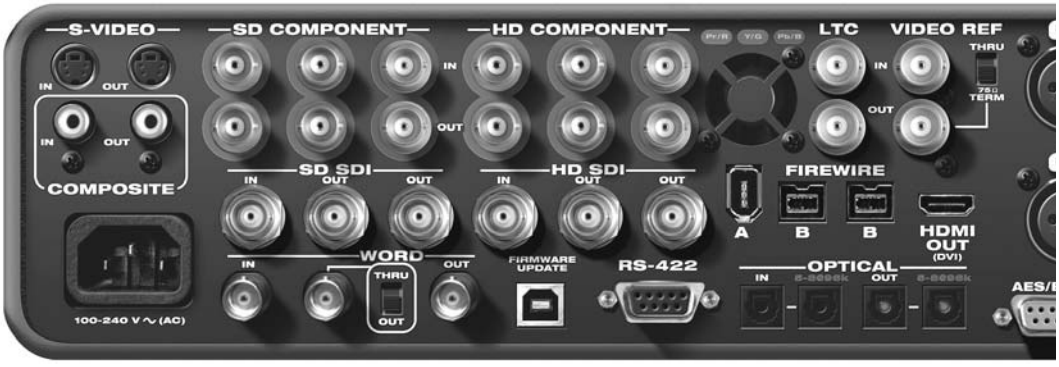


Figure 3-2: The V4HD video connectors.

YPbPr or RGB

The V4HD SD and HD component input and output sections support YPbPr or RGB operation, as shown by the color legend on the rear panel.

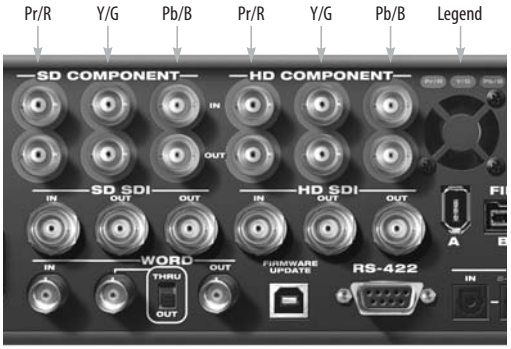


Figure 3-3: The V4HD supports both RGB and YPbPr component video.

Each of the four banks (SD in, SD out, HD in and HD out) can be independently configured for either RGB or YPbPr operation. This setting is made in the MOTU Video Setup software. For the component inputs, see "Video Source menu" on page 44. For the component outputs, see "SD Component Output Color Mode" on page 51 and "HD Component Output Color Mode" on page 51. Be sure that the mode you choose for each bank matches the component video source or destination to which it is connected. If the device you are connecting supports both RGB and YPbPr, use YPbPr, as it is the standard for broadcast video. It is also the native color space for DVCPro compression.

☛ Analog YPbPr component video is sometimes referred to by other names, such as *YUV*, *Y/R-Y/B-Y* or *YCbCr*.

SD (480i) component formats

The V4HD supports four different SD component formats: SMPTE/EBU N10, Sony Beta, Sony Beta Japan and Panasonic MII. This setting is made in the MOTU Video Setup software. See "480i Component Analog Format" on page 49 and "480i Setup" on page 50. For PAL (576i) and HD component operation, the V4HD supports the industry standard SMPTE/EBU N10 specification.

HD-SDI and SD-SDI

The V4HD provides HD-SDI input and output, together with independent SD-SDI input and output, in professional, broadcast quality 10-bit 4:2:2 resolution. For both HD- and SD-SDI, a second output is provided, allowing you to connect a second SDI output device. For example, you could connect an HD monitor, HD video deck, SD monitor and SD video deck, all at the same time, via the four SDI outputs.

For best results, be sure to use cables that are designed for SDI use (such as Belden part number 8281, or similar). The V4HD has been designed to support SDI cable lengths up 500 feet with SDI rated cables.

HDMI / DVI Output

The V4HD provides an HDMI output, which lets you connect any device equipped with an HDMI input. This connector is ideal for connecting a plasma screen, LCD screen or even a home theater receiver. The V4HD supports up to 8 channels of PCM (uncompressed) audio output via the HDMI connection for devices that can receive digital audio via HDMI.

DVI Output

Using a HDMI-to-DVI cable, or a female HDMI-to-male DVI plug adaptor connected to one end of an HDMI-to-HDMI cable, you can connect the V4HD's HDMI output to the DVI input of another device, such as a computer monitor. In addition to the cable connection, you also need to make a software setting that changes the V4HD's HDMI output signal to the DVI format. See "HDMI/DVI" on page 46.

EXAMPLE V4HD VIDEO CONNECTIONS

Here is an example of the types of video devices that you can connect to the V4HD. You can mix and match HD and SD sources and destinations, connect them all, and then choose the desired source from the MOTU Video Setup software.

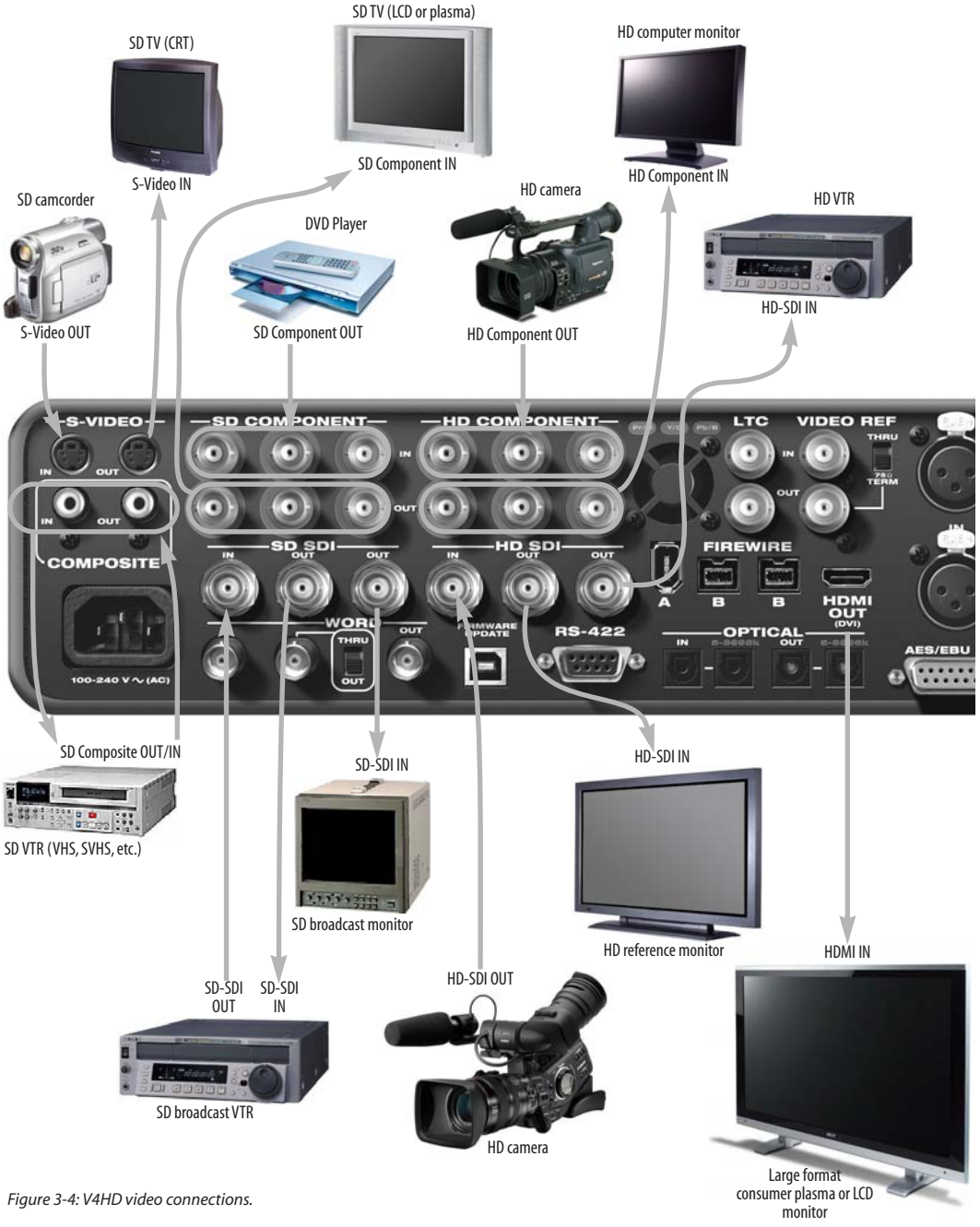


Figure 3-4: V4HD video connections.

CONNECT AUDIO INPUTS AND OUTPUTS

The V4HD provides 32 channels of simultaneous audio input and output (Figure 3-5), grouped in four banks of eight channels each: analog, AES/EBU, optical and embedded (for SDI and HDMI out). For connecting the first three banks, see the following sections. For embedded, make the SDI and/or HDMI connections as described earlier and then enable embedded audio. See "SDI Input and SDI/HDMI Output" on page 75.

Analog audio I/O

The V4HD provides eight channels of analog audio input and output at standard sample rates from 44.1kHz up to 192kHz.

4-channel operation

As shown in Figure 3-5, the Analog Input section and Analog output section each supply four XLR connectors directly on the rear panel. These input and output jacks provide four channels each of analog input and output via direct connection to the V4HD rear panel using standard XLR cables.

8-channel operation

If you need eight channels of analog input or output, a DB25-to-XLR breakout cable (Figure 3-6) is required (sold separately).

For eight channels of analog input, the breakout cable requires a male DB25 connector on one end and eight female XLR connectors on the other end.

For eight channels of analog output, the breakout cable requires a female DB25 connector on one end and eight male XLR connectors on the other end.

Figure 3-6: Examples of DB25-to-XLR breakout cables (sold separately). The cable shown on the left has eight female XLR connectors for eight channels of analog input. For output, you would need a cable with eight male XLR connectors instead. See Appendix D, "DB25 to XLR Pin Outs" page (111) for pin out information.

Within each section (analog in and analog out), XLR and breakout cable operation are mutually exclusive. You cannot use both the XLR jacks and the breakout cable at the same time.

☛ For best performance (and to avoid issues with termination and impedance levels), *do not connect cables to the rear panel XLR jacks and the DB25 cable in the same section at the same time.*

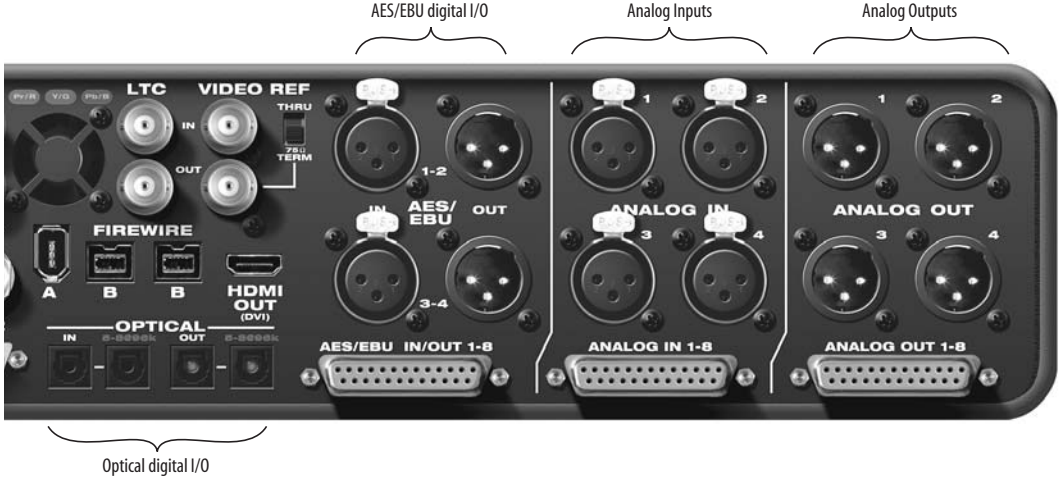


Figure 3-5: The V4HD audio connectors.

AES/EBU digital audio I/O

The V4HD provides eight channels of 24-bit AES/EBU digital audio input and output at standard sample rates from 44.1 kHz up to 96 kHz.

4-channel vs. 8-channel operation

As shown in Figure 3-5, the AES/EBU section supplies four XLR connectors directly on the rear panel. These input and output jacks provide four channels each of AES/EBU digital input and output via direct connection to the V4HD rear panel using standard AES/EBU-grade cables.

Similar to the analog section, as explained in "8-channel operation" on page 24, the V4HD provides eight channels of AES/EBU input or output using a DB25-to-XLR breakout cable (sold separately). However, the requirements for this cable are different than those for the analog section. The AES/EBU breakout cable supplies 8 channels of AES/EBU input on four *female* XLR connectors and 8 channels of AES/EBU output on four *male* XLR connectors, as shown in Figure 3-7.

Figure 3-7: An example of a DB25-to-XLR breakout cable (sold separately) for 8-channel AES/EBU input and output. This cable has four female XLR connectors and four male XLR connectors. See Appendix D, "DB25 to XLR Pin Outs" page (111) for pin out details.

Similar to the analog section, XLR and breakout cable operation in the AES/EBU section are mutually exclusive. You cannot use both the XLR jacks and the breakout cable at the same time.

☛ For best performance (and to avoid issues with termination and impedance levels), *do not connect cables to the rear panel XLR jacks and the DB25 cable in the same section at the same time.*

Synchronization and sample rate conversion

When making AES/EBU digital audio transfers to and from the V4HD, the two devices must be synchronized with one another, or you must employ the V4HD's sample rate conversion. See "Syncing digital audio devices" on page 29.

ADAT optical digital I/O

The V4HD provides 8-channel ADAT optical digital input and output at 44.1, 48, 88.2 and 96 kHz. The V4HD rear panel provides two sets of ADAT optical ("lightpipe") connectors to support 8-channel operation even at the 2x sample rates (88.2 or 96 kHz).

Reminder: optical goes OUT to IN and IN to OUT. Input and output are independent. For example, you could connect ADAT optical input from your digital mixer and connect the output to another optical-equipped device.

Optical operation at 44.1 or 48 kHz

When connected to an ADAT "lightpipe" compatible device, the two optical connectors marked *IN* and *OUT* provide eight channels of digital input and output at 44.1 and 48 kHz.

In addition, when operating the V4HD at a 1x sample rate (either 44.1 or 48 kHz), optical output is duplicated on the second optical output marked *5-8@96K*. This lets you send the V4HD's 8-channel ADAT optical output to two separate destinations in your studio, if needed.

Optical operation at 88.2 or 96 kHz

When operating the V4HD at the 2x sample rates (88.2 or 96 kHz), the two optical connectors marked *IN* and *OUT* provide channels 1-4 (in and out) and the second set of optical connectors marked *5-8@96K* provide channels 5-8 (in and out) when connected to another optical device that supports 88.2/96 kHz optical sample rates.

When operating the optical ports at a 2x sample rate, be sure to choose either Type I or Type II operation, as explained in “ADAT Type” on page 99.

Synchronization and sample rate conversion
When making optical digital audio transfers to and from the V4HD, the two devices must be synchronized with one another, or you must employ the V4HD’s sample rate conversion. See “Syncing digital audio devices” on page 29.

EXAMPLE V4HD AUDIO CONNECTIONS

Figure 3-8 shows an example of the types of audio connections you can make between other devices and the V4HD. You can mix and match analog and digital sources and destinations, connect them all, and then mix them using the *CueMix FX* software. The 8-channel banks of optical and AES/EBU digital I/O are ideal for connection to a digital mixer.

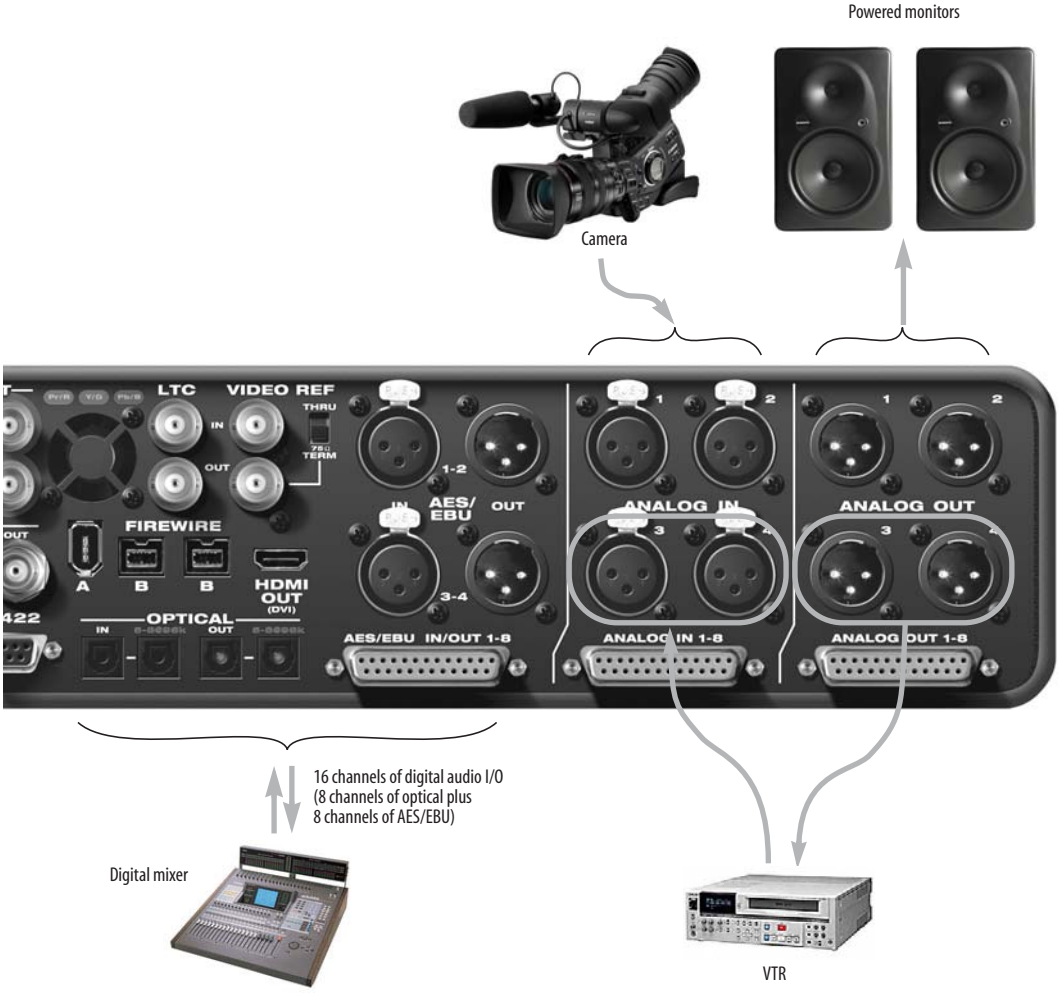


Figure 3-8: V4HD audio connections.

VIDEO SYNC CONNECTIONS

Connect a video sync source, such as blackburst, to the VIDEO REF IN jack (Figure 3-9). This input accepts either a Bi-level (SD) sync source or a Tri-level (HD) sync source. The V4HD can resolve to a VIDEO REF IN signal only when it is in Playback mode. When it is in Capture or Convert mode, it genlocks to the current video source. For further information, see "Playback Clock Source" on page 53.

Video ref termination and "thru"

The V4HD lets you daisy-chain the VIDEO REF signal to another video device using the THRU jack below the VIDEO REF jack. If you connect a device to the THRU jack, set the termination switch (Figure 3-9) to the *THRU* position.

If the V4HD is the only device (or the last device in a daisy-chain), set the termination switch to the *75Ω TERM* position. This is crucial for successful genlock.

Figure 3-9: Video sync connectors.

TIME CODE CONNECTIONS

Connect any time code source, such as the time code output from a camera or VTR, to the LTC IN jack (Figure 3-9). If you wish to transmit time code from the V4HD to another device, connect the V4HD LTC OUT to the time code input on the other device. See chapter 10, "MOTU SMPTE Setup" (page 87) for information about managing the V4HD's time code features.

AUDIO WORD CLOCK

The V4HD word clock connectors (Figure 3-10) allow you to synchronize it with any other word clock-equipped device.

Figure 3-10: Audio word clock connectors.

For standard word clock sync, you need to choose an audio clock master. In the simplest case, you have two devices and one is the word clock master and the other is the slave as shown in Figure 3-15.

When the video features of the V4HD are disabled (see "Enable Video" on page 50) and the V4HD is operating as an audio interface, you can resolve the V4HD to another device: connect its word clock output to the V4HD's WORD IN jack (Figure 3-11).

Figure 3-11: Slaving the V4HD to word clock. For the V4HD clock source, choose 'Word Clock In'. This configuration is only supported when the V4HD is running in Audio Only mode (video features are disabled).

To resolve another device to the V4HD (even when video is enabled), connect the V4HD's WORD OUT jack to the word clock input on the other device (Figure 3-12).

Figure 3-12: Slaving another digital audio device to the V4HD via word clock. For the V4HD clock source, choose 'Video Clock' or, if the V4HD is in Audio Only mode, any other clock source besides word clock.

Word clock out/thru

The V4HD provides a third word clock output that can function either as a second output or as a word clock thru jack. Just set the accompanying switch as desired. In Thru mode, termination is disabled so that you can daisy chain another word clock device. Make sure the device has its own proper termination for the end of the word clock chain.

Slaving to a 2x and 1/2x word clock

The V4HD has the ability to slave to a word clock signal running at either twice or half their current clock rate. For example, the V4HD could be running at 96 kHz while slaving to a 48 kHz word clock signal from another device. Similarly, the V4HD could run at 88.2 kHz and slave to 44.1 kHz word clock. Conversely, the V4HD could run at 48 kHz and slave to a 96 kHz word clock signal.

Remember, the word clock signal must be one of the following:

- the same as the V4HD clock
- twice the V4HD clock
- half of the V4HD clock

Forcing a 1x word out rate

When the V4HD is operating at a 2x or 4x sample rate, it can generate a word clock output signal that either matches the current system clock rate (any rate between 88.2 and 192kHz) or the corresponding 1x rate. For example, if the V4HD is operating at 192kHz, you can choose to generate a word out rate of 48kHz. For details on how to make this word clock output setting, see "Word Out" on page 77.

RS-422 MACHINE CONTROL

If you have a VTR or other device equipped with Sony 9-pin compatible machine control, and you would like to control it using Final Cut Pro's machine control features, connect its RS-422 port to the V4HD's RS-422 port (Figure 3-13). Also see "Device control" on page 66.

Figure 3-13: RS-422 machine control.

SYNCING DIGITAL AUDIO DEVICES

If you would like to transfer audio digitally between the V4HD and another device that has AES/EBU or ADAT optical digital I/O, there are three basic scenarios in which the V4HD could make a digital audio transfer:

- The V4HD video features are enabled and it is therefore resolved to its video clock.
- The V4HD video features are disabled, and you are running the V4HD as an audio interface (see "Audio only" on page 39).
- Regardless of the V4HD's current operational mode, you would like to use the V4HD's digital audio sample rate conversion feature.

The audio clock synchronization requirements for these three scenarios are described in the following sections, starting with a general discussion of digital audio phase lock, and why it is essential for clean and successful digital audio transfers.

Digital audio phase lock

Without sample rate conversion, when you transfer digital audio between two devices, their audio clocks must be in phase with one another — or *phase-locked* — as demonstrated below in Figure 3-14. Otherwise, you'll hear clicks, pops, and distortion in the audio, or perhaps no audio at all.

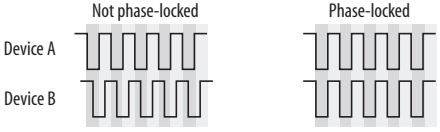


Figure 3-14: When transferring audio without sample rate conversion, two devices must have phased-locked audio clocks to prevent clicks, pops or other artifacts.

Without sample rate conversion, there are two ways to achieve phase lock: slave one device to the other, or slave both devices to a third master clock. If you have three or more digital audio devices, you need to slave them all to a single master audio clock.

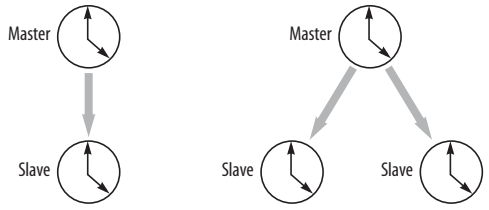


Figure 3-15: Without sample rate conversion, you need to choose a clock master to which all other devices slave. Each slaved device remains continuously resolved to the master, meaning that there will be no drift over time.

Audio phase lock as shown above in Figure 3-15 can be achieved independently of time code (location). For example, one device can be the time code master while another is the clock master. But only one device can be the audio clock master.

Another benefit of direct master/slave clocking (without sample rate conversion) is that each slaved device remains continuously resolved to the master, which means that there will be no gradual drift over time. This form of synchronization is best for audio that must remain resolved to picture.

Audio synchronization when capturing, converting or playing video

When the V4HD is capturing, converting or playing video (as further explained later in "Five modes" on page 37), its audio clock (see "Clock Source" on page 73) resolves to its video clock. The V4HD has three possible sources for video clock:

- The currently chosen video source (Figure 6-3 on page 43 and Figure 6-5 on page 44)
- The VIDEO REF IN jack
- The V4HD's own internal video clock, when it is playing from the computer, or in *Playback only* mode (page 38)

Resolving to the current video source

If the V4HD is transmitting or receiving digital audio from the current video source, the video genlock between the two devices ensures that their digital audio clocks remain resolved and phase locked, as demonstrated in Figure 3-16:

Figure 3-16: When capturing digital audio from the current video source, the V4HD genlocks to the source input, which keeps the digital audio clock properly resolved to the video source audio clock.

Resolving a third device to the V4HD

If you need to make digital audio transfers between the V4HD and third device (that is not the current video source), you must resolve the third device to the V4HD, as demonstrated in Figure 3-17. In this example, the third device, a field recorder, is being resolved to the V4HD via word clock. Alternately, it could be resolved via AES/EBU or ADAT optical input.

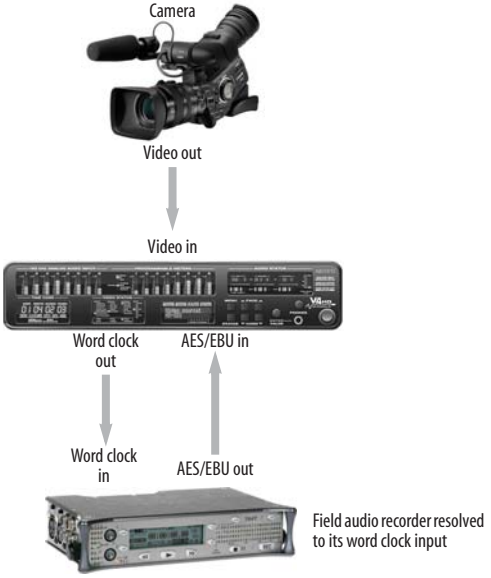


Figure 3-17: Capturing digital audio from a third device that is not the current video source. In this case, the third device must resolve to the V4HD via word clock in, AES/EBU input or ADAT optical input.

Resolving a digital mixer to the V4HD

If the V4HD is currently operating as a video interface (i.e. *Audio only* mode is not enabled), and you would like to connect a digital mixer via ADAT optical or AES/EBU (or both), resolve the digital mixer to the V4HD, either via its optical or AES/EBU connection, or via word clock, similar to what is shown in Figure 3-17.

Resolving to the VIDEO REF IN

If the V4HD is currently resolved to its VIDEO REF IN, you can either resolve the other digital audio device to the V4HD (Figure 3-17), or you can resolve the other device to the same genlock source that is feeding the V4HD's VIDEO REF IN. In this scenario, the genlock source serves as a master clock to which both the V4HD and the other device are resolved (Figure 3-15).

Digital audio transfers in Playback only mode

When the V4HD is in Playback only mode (see "Playback / Playback only" on page 38), resolve other digital audio devices to the V4HD, either via their optical or AES/EBU connection, or via word clock, similar to what is shown in Figure 3-17.

Audio synchronization in 'Audio only' mode

If the V4HD video features are disabled with "Audio only" mode (page 39), then the V4HD operates as an audio interface with a variety of options for digital audio clocking (without requiring sample rate conversion). You can resolve other digital audio devices to the V4HD or vice versa, using word clock or their digital audio connections (ADAT optical or AES/EBU).

If you choose the V4HD as the clock master, set its audio clock source ("Clock Source" on page 73) to *Internal* and resolve the other device to its word clock or digital audio connection to the V4HD.

If you choose the other device, such as a digital mixer, as the clock master, resolve the V4HD to it via word clock in, AES/EBU in or ADAT optical in, as demonstrated below in Figure 3-18.

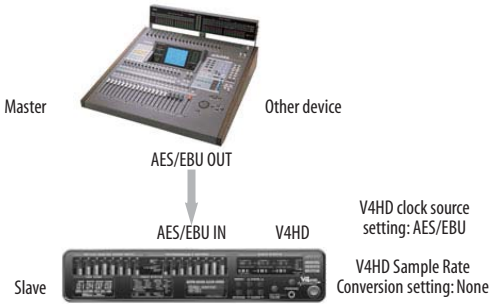


Figure 3-18: Slaving the V4HD to an AES/EBU device. For the V4HD's clock source, choose 'AES/EBU'.

Or you can resolve both the mixer and the V4HD to a third clock master device.

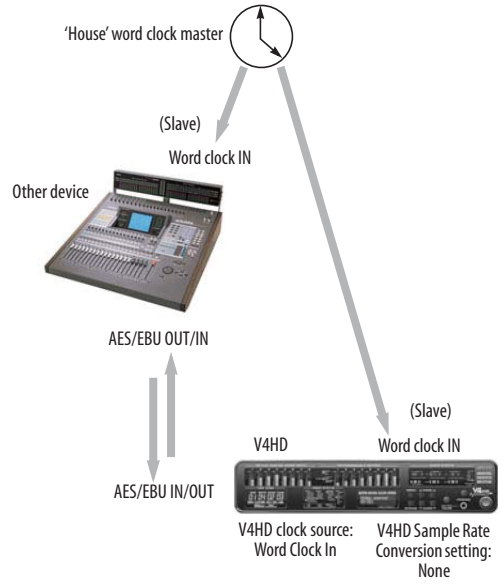


Figure 3-19: In this scenario, the V4HD and other AES/EBU device are both resolved to one another via a third master word clock source.

Sample rate conversion

The V4HD is equipped with one 8-channel bank of real-time sample rate conversion that can be assigned to any individual input or output bank using the "Sample Rate Convert" software option (page 75). This feature provides a great deal of flexibility in making digital transfers. For example, you can:

- Transfer digital audio into the V4HD at a sample rate that is completely different than the V4HD system clock rate.
- Transfer digital audio into the V4HD without the need for any external synchronization arrangements.
- Transfer digital audio out of the V4HD at double or half the V4HD system clock rate.
- Transfer digital audio running at a 1x or 2x sample rate (from 44.1 kHz to 96 kHz) in or out of the V4HD while the V4HD is running at a corresponding 4x sample rate (176.4 or 192 kHz)

Rate conversion does not add any appreciable noise to the audio signal (under -120 dB).

With sample rate conversion (SRC), an extra level of master/slave clocking is added to the equation, as demonstrated below in Figure 3-20, which shows the clocking going on when you transfer digital audio from the V4HD(AES/EBU out) to a video deck (AES/EBU in) using SRC. Notice that with SRC, the video deck is not slaved to the V4HD's system clock. Instead, their clocks are running completely independently of one another. But also notice that the video deck must still slave to the sample-rate-converted output from the V4HD for a clean digital audio transfer (unless it has its own sample rate converter on its AES/EBU input).

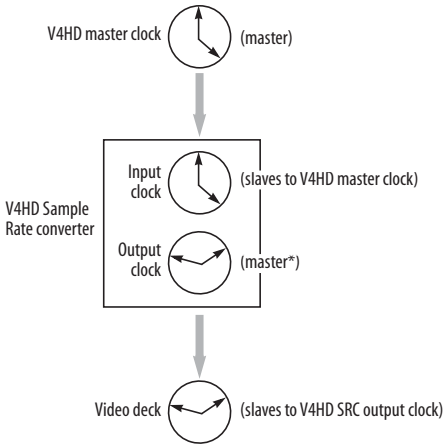


*Figure 3-20: Clock relationships when sending audio from the V4HD to a video deck using sample rate conversion. The video deck needs to be slaving to its AES/EBU input. *Note: the V4HD AES/EBU output can be clocked from a number of different sources. In this example, it is resolved to the V4HD system clock. For details about other possible clock sources, see "Rate convert options for digital audio output" below.*

Here are a few examples:

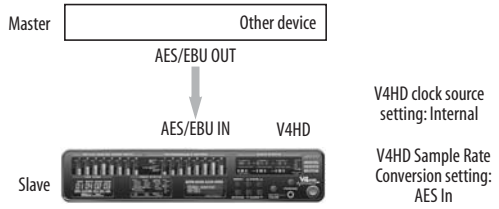


Figure 3-21: Rate-converting AES/EBU input.

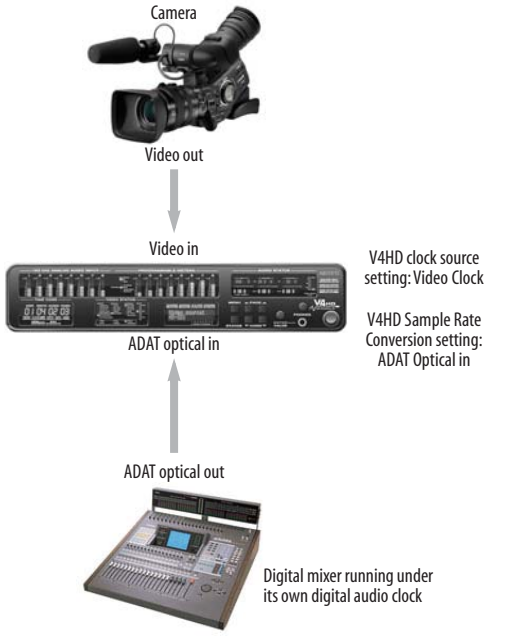


Figure 3-22: Capturing digital audio from a device that is not resolved with the V4HD. In this case, sample rate conversion is used.

A caution about using rate conversion

Rate conversion can be a life saver in situations where resolving digital audio clocks is difficult or impossible. However, when you do so, you run the risk of the audio drifting apart from picture over time. If the audio clip being captured is short, this may not be an issue. But for longer record/playback passes (more than a few minutes), you are much better off resolving the V4HD to picture during the digital audio transfer.

Most devices employ a clock crystal that has an accuracy of ±50 parts per million, which produces drift that amounts to approximately one frame every five minutes at 60 fps.

Rate convert options for digital audio output

The V4HD digital audio output banks can also employ sample rate conversion. For details see "Sample Rate Convert" on page 75.

CHAPTER 4 Installing the V4HD Mac OS X Software

SOFTWARE INSTALLATION FOR MAC OS X

Install the V4HD software as follows:

1 Insert the V4HD Installer CD and launch the installer.

2 Follow the installer's directions.

What does the OS X installer do?

The installer checks the computer to make sure it satisfies the minimum system requirements for your MOTU video interface. If so, the installer proceeds with the OS X installation. Drivers are installed, along with Final Cut Pro Easy Setups and several support applications, summarized in the table below.

V4HD Easy Setups for Final Cut Pro

Easy Setups are a convenient way to universally configure all of the crucial settings for the V4HD in Final Cut Pro, according to video format you choose for your project. The V4HD Easy Install option installs dozens of Easy Setups for your convenience.

Software component	Location	Purpose	For more information
MOTUFireWireVideoConfig.kext	/System/Library/ Extensions	Provides V4HD video input and output for Final Cut Pro via FireWire.	-
MOTUFirewireAudio.kext	/System/Library/ Extensions	Provides V4HD multi-channel audio input and output for Final Cut Pro via FireWire.	-
MOTUVOut.component	/Library/Quicktime	Provides support for the V4HD's video features.	-
FCP MOTU RT Enabler.txt	Library/Application Support/Final Cut Pro System Support/ Plugins	Provides real time output to the V4HD's video outputs.	-
MOTU V4HD Easy Setups	Library/Application Support/Final Cut Pro System Support/ Custom Settings/	Provides over 60 Easy Setups for Final Cut Pro's Easy Setup feature. These help you quickly configure Final Cut for the V4HD.	See "Easy setups" on page 58
MOTU Video Setup	Applications folder	Provides access to all of the V4HD's video settings.	See chapter 6, "MOTU Video Setup" (page 41)
MOTU Audio Setup	Applications folder	Provides access to all of the audio settings in the V4HD and other MOTU interfaces connected to the computer.	See chapter 8, "MOTU Audio Setup" (page 71)
MOTU SMPTE Setup	Applications folder	Provides access to the V4HD's time code sync features.	See chapter 10, "MOTU SMPTE Setup" (page 87)
CueMix FX	Applications folder	Gives you complete control over the V4HD's CueMix mixing feature, which provides no-latency monitoring and mixing of live inputs through your V4HD system.	See chapter 9, "CueMix FX" (page 79)

Part 2
Video Operation

CHAPTER 5 V4HD Basics

ONE INPUT TO ALL OUTPUTS

The basic design concept of the V4HD is that you choose a video input and the V4HD sends the signal to all outputs, converting the signal where necessary to conform to the output format, regardless of the input signal format. Most common conversions are supported, although not all. In those few cases, the corresponding output does not produce a signal.

This allows you to simultaneously connect a number of input devices, such as cameras, video decks, DVD players, etc., along with a number of output devices, such as monitors, video decks and other destinations. Then choose the desired input device and the V4HD will feed that signal to all output destinations simultaneously.

The settings in the MOTU Video Setup software let you conveniently manage the V4HD's many routing and conversion features.

Think of FireWire as another input or output

FireWire is, of course, the V4HD's connection to the computer. However, it might be useful to think of the FireWire cable as another video input and output. It can be disabled or chosen as the current video source, just like one of the video connectors on the rear panel of the V4HD.

Choosing the current video source

The MOTU Video Setup software lets you choose the current video source (input). For details, see "Video Source menu" on page 44. This can also be done from the front panel LCD. See "Video menu" on page 98.

Audio I/O and monitoring

On the audio side of things, the V4HD feeds audio input to the computer and plays audio back from the computer, so that you can easily capture and playback audio in Final Cut Pro. But the V4HD also has a powerful mixer that lets you route inputs to outputs, independently of what is going on with capture and playback on the computer. This powerful audio monitor mixer is managed from the CueMix FX software (page 79).

FIVE MODES

The V4HD provides five modes of operation:

- Capture
- Convert
- Playback / Playback only
- Audio only
- Standalone (video or audio only)

The current mode is clearly indicated by the MODE LEDs in the VIDEO STATUS section of the front panel (Figure 5-1). In some cases, multiple LEDs may illuminate, such as the Standalone and Audio only LEDs, to indicate Standalone/audio only mode.

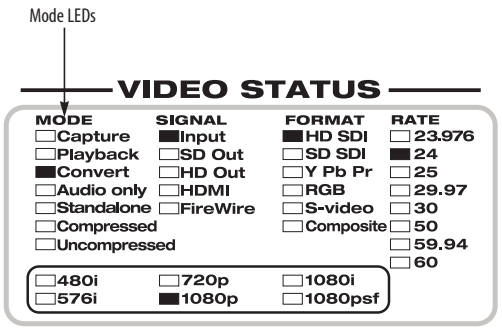


Figure 5-1: The MODE bank of LEDs in the VIDEO STATUS section.

Capture

The V4HD is in *Capture* mode when it is connected to the computer and video software has actively taken control of the V4HD hardware for the purposes of capturing video and audio from the V4HD via the FireWire connection. Here are some examples of when video software would put the V4HD into Capture mode:

- You open the Log and Capture window in Final Cut Pro. Or you use any Final Cut Pro feature, such as Edit to Tape, that involves capturing or previewing the live video input from the V4HD.
- You run the MOTU Video Setup software and click the Preview tab (Figure 6-1 on page 41, Figure 6-26 on page 52). This causes MOTU Video Setup to "take over" the FireWire video signal being supplied by the V4HD and display it in the preview window.

In capture mode, only one software application has access to the V4HD at a time. For example, when the Video Setup is the active application and the Preview tab is selected, Final Cut Pro will not see the V4HD hardware at all. To give control to Final Cut Pro, simply switch to Final Cut Pro. For further information, see "Preview" on page 52.

Even though the primary purpose of Capture mode is to feed video to the computer via FireWire, the V4HD continues to simultaneously convert the source video signal and send it to all video outputs as well. This allows you to simultaneously monitor what you are capturing using any combination of the V4HD's video outputs. You could even dub the source signal to a video deck or other video recorder during capture.

Convert

Convert mode is almost identical to Capture mode (above), except that the V4HD does not feed video to FireWire and the computer. However, the currently selected video source is still fed to all other V4HD video outputs. Convert mode serves as a "default" mode for the V4HD, when none of the other modes are currently engaged.

Playback / Playback only

The V4HD goes into *Playback* mode when an application is sending video to it. For example, Final Cut Pro puts the V4HD into playback mode when *All Frames* or *Single Frames* is selected in the *External Video* sub-menu or when using *Print to Video*. Otherwise, the V4HD reverts to Convert mode, or Capture mode when you go into the Log and Capture window.

Mode	Description	Video Inputs active	Video Outputs active	FireWire capture	Clock source
Capture	FireWire video capture, with all outputs active.	Yes	Yes	Yes	Video source
Convert	All outputs active, no FireWire capture.	Yes	Yes	No	Video source
Playback / Playback only	Inputs disabled, playback from Final Cut Pro.	No	Yes	No	V4HD video clock
Audio only	Video I/O is disabled. V4HD operates as a FireWire audio interface.	No	No	Audio only	Audio clock source (page 73)
Standalone video	V4HD is disconnected from the computer and operates as a standalone video converter and audio mixer.	Yes	Yes	No	Video source
Standalone audio	V4HD is disconnected from the computer and operates as a standalone audio mixer only.	No	No	No	Audio clock source (page 73)

Figure 5-2: Summary of V4HD modes.

The *Playback Only (disable inputs)* option in the MOTU Video Setup software Setup tab (Figure 6-19 on page 48) lets you force the V4HD to stay in playback mode. Playback Only mode is useful when you are at a point in your workflow where you are not doing any capturing. For example, you may have no inputs connected to the V4HD hardware, or you may have inputs connected, but you are not currently using them. Playback Only mode keeps the V4HD hardware from switching back and forth unnecessarily between Playback and Convert (or Capture) modes.

Audio only

In *Audio only* mode, all of the V4HD video features are disabled and the V4HD operates as a 24-channel FireWire audio interface, which provides three 8-channel banks of analog, AES/EBU and ADAT optical I/O. (The fourth bank, embedded audio, is disabled in this mode since there is no video signal in which the audio could be embedded.) To engage *Audio only* mode, go to the Setup tab in the MOTU Video Setup software (Figure 6-1 on page 41) and disable the *Enable Video* option (Figure 6-19 on page 48).

You must use Audio Only mode if you want to resolve the V4HD's digital audio clock to an external source, such as word clock, ADAT optical or AES/EBU. For further information, see "Syncing digital audio devices" on page 29.

Standalone

To put the V4HD in *Standalone* mode, unplug its FireWire cable connection to the computer, or turn off the computer. Standalone mode is very similar to Convert mode: no video goes to FireWire and the computer because it is disconnected, but the currently selected video source is fed to all other V4HD video outputs.

In standalone mode, you can use the front panel LCD to put the V4HD into Audio only mode (see "AV Mode" on page 102). Doing so turns the V4HD into a standalone 24-channel, 12-bus audio mixer. You can control the mixer from the front panel LCD. See "CueMix Menu" on page 99.

CHAPTER 6 MOTU Video Setup

MOTU Video Setup (Figure 6-1) is installed in your Mac's Applications folder and provides convenient access to all V4HD settings from your computer desktop.

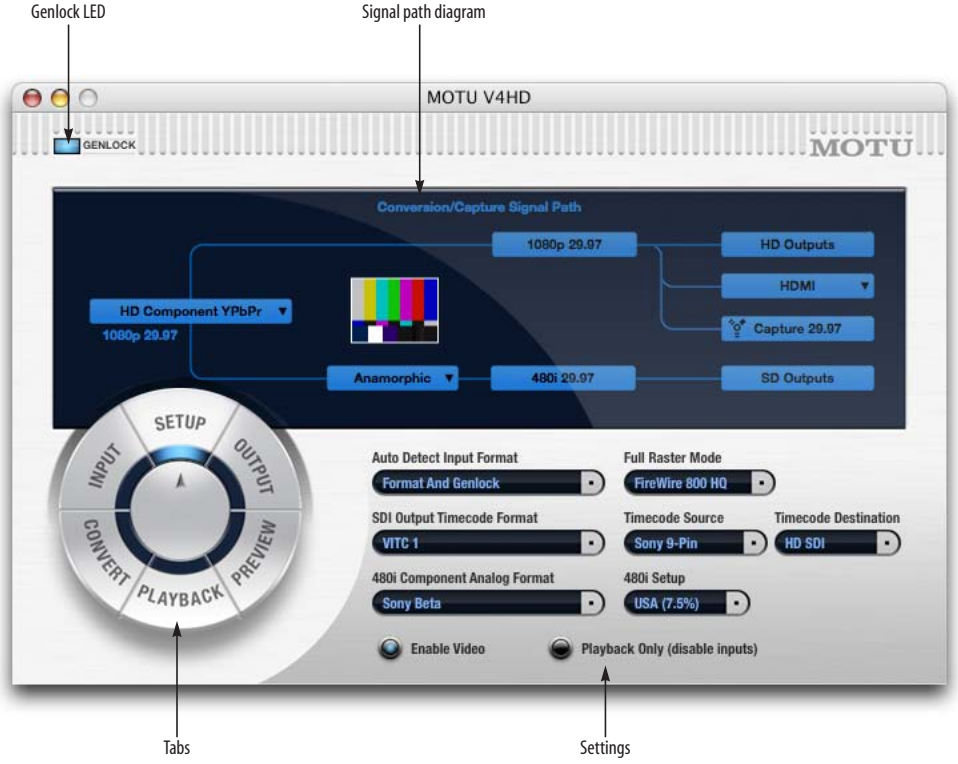


Figure 6-1: MOTU Video Setup.

SIGNAL PATH DIAGRAM

The Signal Path Diagram (Figure 6-2, Figure 6-3) lets you view and control the V4HD's hardware-based video conversion features and signal flow settings. The Signal path Diagram lets you pre-configure and store independent settings for five common operational scenarios:

- Convert and Capture
- 480 playback
- 576 playback
- 720 playback
- 1080 playback

The Signal Path Diagram shows one set of settings at a time, allowing you to pre-configure and save unique settings for each of the five situations listed above. In the case of the four playback formats, the settings you make for each format will go into effect when you play back material in that format from Final Cut Pro.

In most situations, the Signal Path Diagram lets you access the settings for a mode, even when the hardware is not currently in that mode. Displaying the settings for a mode doesn't put the V4HD in that mode. For information about controlling what mode the V4HD is in, see chapter 5, "V4HD Basics" (page 37).

Signal path layout

The signal path diagram proceeds from left to right, with the source menu on the left, destinations on the right, and controls for each format placed along the signal path in the form of informational blocks or menus that let you view and modify settings. The upper path represents the V4HD hardware's HD signal path and the lower path represents the V4HD hardware's SD signal path.

Playback signal path

To view the Playback Signal Path settings, put the V4HD in Playback only mode (as explained in chapter 5, "V4HD Basics"), or click the Playback tab (Figure 6-1). In either case, the signal path diagram shows the *Playback Signal Path* (Figure 6-2).

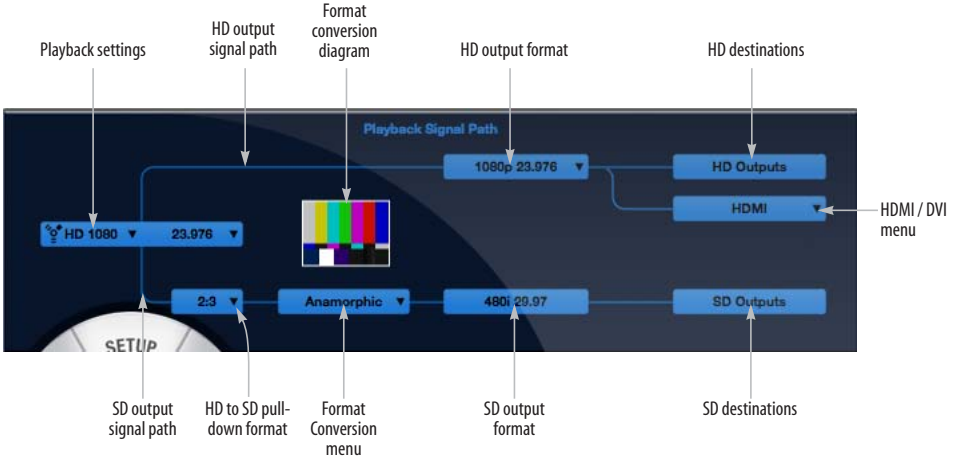


Figure 6-2: Playback Signal Path.

Playback settings menu

The *Playback Settings* menu (Figure 6-2) lets you choose one of four sets of playback settings to view in the signal path diagram. There are separate settings for 480, 576, 720 and 1080 playback (Figure 6-4). When you choose a format from this menu, the settings for the format are displayed in the Playback Signal Path diagram. When Final Cut Pro is running, this menu becomes inactive and simply displays the Final Cut Pro timeline format and frame rate.

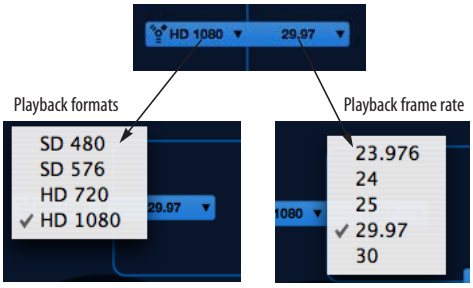


Figure 6-4: The Playback Settings menu.

When you play back video from Final Cut Pro, the V4HD hardware detects the video format being output by Final Cut Pro and distributes it to the V4HD hardware HD and SD destinations according to the settings you've made for that format. Whenever playback starts, the MOTU Video Setup software automatically switches to the Playback tab to show the settings for the format being played.

Playback frame rate

Choose the desired *playback frame rate* (Figure 6-4) you wish to work with in the Playback Signal Path diagram. The frame rate you choose here should match what you intend to use in Final Cut Pro, and it determines what other hardware settings you'll see in the Playback Signal Path diagram, such as up or down conversion formats, pull-down insertion, etc.

Convert/Capture signal path

If the V4HD is not in Playback Only mode (as explained in chapter 5, "V4HD Basics"), click any other tab besides the Playback tab (Figure 6-1) to view the *Conversion/Capture Signal Path* settings in the signal path diagram (Figure 6-3). Unlike the four sets of playback settings, there is only one set of conversion/capture settings. Changing Conversion/Capture settings in the signal path diagram changes these settings immediately in the hardware.

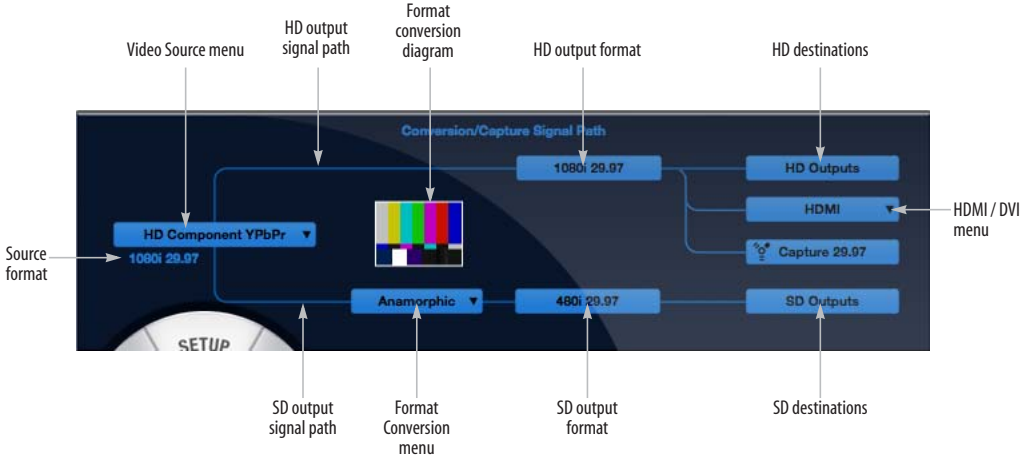


Figure 6-3: Convert/Capture Signal Path.

Video Source menu

The *Video Source menu* (Figure 6-3) is important because this is where you choose the video input from which the V4HD will convert and capture. Choose any SD or HD source (Figure 6-5), and the V4HD converts it to all output formats and sends it over Firewire to the computer.

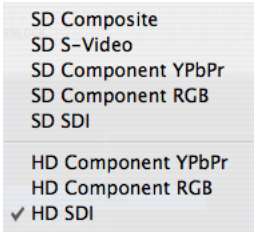


Figure 6-5: The Video Source menu.

When you choose a source, the V4HD can auto-detect the frame rate and format of the incoming video (see "Auto Detect Input Format" on page 48).

Format Conversion menu

The *Format Conversion* menu (Figure 6-3) lets you choose the formatting for SD to HD up conversion or HD to SD down conversion. The format conversion color bar diagram (Figure 6-3) provides a thumbnail illustrating the resulting formatting. The color bars represent the original source signal and the boxed boundary represents the destination frame.

HD to SD down conversion formats

When an HD source is chosen in the Video Source menu (Figure 6-5), the format conversion menu appears along the SD signal path, as demonstrated in Figure 6-3. The menu provides the following HD to SD down conversion formatting options:

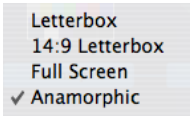


Figure 6-6: HD to SD down conversion formatting options.

Letterbox (HD to SD)

Letterboxing is the standard practice of conforming widescreen film images such as film or HD to an SD video frame while preserving the original aspect ratio. Since the SD video frame is more square than the widescreen frame, the resulting image has "black bars" or mattes above and below the image (Figure 6-7).

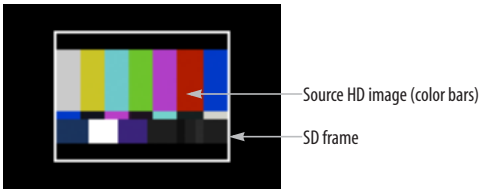


Figure 6-7: Letterbox formatting.

The *Letterbox* option (Figure 6-6) preserves the aspect ratio of the HD source signal while filling the SD frame edge to edge (left to right). Black bars are added to fill the unused portion of the frame above and below (Figure 6-7). No cropping occurs and the full image is preserved.

14:9 Letterbox (HD to SD)

With the 14:9 *Letterbox* option (Figure 6-6), aspect ratio is preserved (Figure 6-8) and some cropping occurs on the left and right edge, but not as much as in Full Screen mode (explained below). In addition, the letterbox bars are smaller. In essence, this mode scales the image larger than letterbox mode, but not as much as Full Screen mode, with less left- and right-edge cropping than Full Screen mode and smaller letterbox bars.

Figure 6-8: 14:9 letterbox formatting.

Full Screen (HD to SD)

The *Full Screen* option (Figure 6-6) also preserves the aspect ratio of the HD image but scales it proportionally to fill the full height of the SD frame (Figure 6-9). As a result, the portions of the HD image that fall outside the frame (along the left-hand and right-hand edges) are cropped. But the full height of the SD frame is used.

Figure 6-9: Full Screen formatting.

Anamorphic (HD to SD)

The *Anamorphic* option (Figure 6-6) does not preserve the aspect ratio of the HD image. Instead, it scales the image to fill the full height of the SD frame, but it also distorts the HD image horizontally so it squeezes into the SD frame (Figure 6-10). As a result, the entire HD image is preserved, but it appears horizontally compressed. This option is good for SD material that will be displayed on a widescreen TV, where it can be horizontally expanded back to an aspect ratio that is close to the aspect ratio of the original HD image.

Figure 6-10: Anamorphic formatting.

SD to HD up conversion formats

When an SD source is chosen from the Video Source menu (Figure 6-5), the Format Conversion menu appears in the HD signal path, as shown below in Figure 6-11:

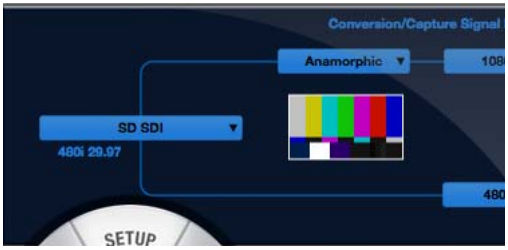


Figure 6-11: SD to HD Format Conversion.

The menu provides the following SD to HD up conversion formatting options:

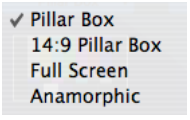


Figure 6-12: SD to HD up conversion formatting options.

Pillar Box (SD to HD)

Pillar box formatting is a method for conforming SD video to an HD video frame while preserving the original aspect ratio. Since the HD video frame is more rectangular than SD video, the resulting image has "black bars" or mattes on either side of the image (Figure 6-13).

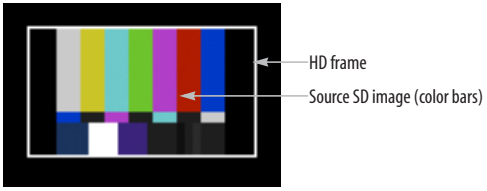


Figure 6-13: Pillar Box formatting.

The *Pillar Box* option (Figure 6-12) preserves the aspect ratio of the SD source signal while filling the HD frame top to bottom. Black bars are added to

fill the unused portion of the frame on either side (Figure 6-13). No cropping occurs and the full image is preserved.

14:9 Pillar Box (SD to HD)

With the 14:9 *Pillar Box* option (Figure 6-12), aspect ratio is preserved (Figure 6-14) and some cropping occurs on the top and bottom edge, but not as much as in Full Screen mode (explained below). In addition, the pillar box bars are smaller. In essence, this mode scales the image larger than Pillar box mode, but not as much as Full Screen mode, with less top- and bottom-edge cropping than Full Screen mode and smaller pillar box bars.

Figure 6-14: 14:9 Pillar Box formatting.

Full Screen (SD to HD)

The *Full Screen* option (Figure 6-12) preserves the aspect ratio of the SD image, but it scales it proportionally to fill the full width of the HD frame (Figure 6-15). As a result, the portions of the SD image that fall outside the frame (along the top and bottom edges) are cropped. But the full width of the HD frame is used.

Figure 6-15: Full Screen formatting.

Anamorphic (SD to HD)

The *Anamorphic* option (Figure 6-12) does not preserve the aspect ratio of the SD image. Instead, it scales the image to fill the full width of the HD frame, but it also distorts the SD image vertically so that expands to fill the HD frame (Figure 6-16). As a result, the entire SD image is preserved, but it appears horizontally expanded.

Figure 6-16: Anamorphic formatting.

SD/HD output format

The *SD output format* and *HD output format* blocks in the signal path diagram (Figure 6-3) indicate the specific format and frame rate that the V4HD is currently converting and sending to its SD and HD outputs. If the "Auto Detect Input Format" option (page 48) is set to *Manual* or *Genlock*, these blocks turn into menus from which you can specify the format being captured and converted from the source currently chosen in the Video Source menu (Figure 6-3). When the "Auto Detect Input Format" is set to *Format and Genlock*, depending on the situation, these menus will let you choose the output format for the non-source path. For example, if you currently have an SD source, this menu will let you choose the HD output format.

☛ SD output is disabled when the HD frame rate is set to 24, 30, or 60 (as opposed to 23.976, 29.97, or 59.94).

Destinations

The *Destinations* on the far right of the signal path diagram (Figure 6-3) display where the HD and SD video signals go.

HDMI/DVI

The *HDMI/DVI* menu (Figure 6-3) lets you choose the output format for the HDMI output on the rear panel of the V4HD. If you choose DVI, you'll need an HDMI-to-DVI cable or adapter.

The V4HD's HDMI/DVI output can send either the SD or HD video signal. Use the "HDMI Output Source" setting (page 51) in the Output tab to specify either SD or HD. If you choose HD, the HDMI/DVI block in the signal path diagram connects to the HD signal path, as shown in Figure 6-3. If you choose SD, it connects to the SD signal path, as shown in Figure 6-25.

FireWire

Your host software running on the computer is represented by the block labeled with the FireWire icon (Figure 6-3). Notice that this block can be fed by either the HD or the SD signal path, depending on the *Preview Format* setting (Figure 6-26 on page 52). This block is not present in the Playback Signal Path diagram (Figure 6-2), since the V4HD does not feed a signal to the computer in this mode.

The pull-down menu

Pull-down is a process used to convert 23.976 fps film footage to 29.97 interlaced video. Reverse pull-down, or pull-down removal, can be used to restore the original film frame rate. These processes involve the addition or removal of interlaced video fields. For a complete explanation, refer to the *Final Cut Pro User Manual*.

If the V4HD video source is running at 23.976 or 24 fps, and it is being sent to an output at a different frame rate (29.97, 30, 59.94 or 60), the signal path diagram displays a pull-down menu (Figure 6-17) that lets you choose which cadence of pull-down will be inserted: either 2:3 or 2:3:3:2 pull-down.

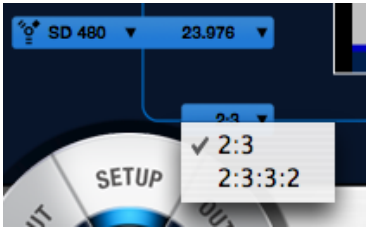


Figure 6-17: Pull-down menu.

Pull-down insertion is supported in the following cases:

- Converting any 23.976 fps HD signal to 480i29.97 (This can be done in any mode: capture, convert, or playback.)
- Playing back 480p23.976, converting to 480i29.97 and 23.976 fps HD (720p23.976, 1080p23.976 or 1080PsF 23.976)
- Playing back 1080p23.976, converting to 1080i29.97 and 480i29.97
- Playing back 720p23.976, converting to 720p59.94 and 480i29.97
- Playing back 1080p24, converting to 1080i30 (SD is disabled in this case.)
- Playing back 720p24, converting to 720p60 (SD is disabled in this case.)

Pull-down detection and removal

The V4HD automatically detects and removes pull-down in the following conversion situations:

- Convert 480i29.97 to 23.976 fps HD (720 or 1080)
- Convert 480i29.97 to 23.976 fps HD (720 or 1080) and capture as 480p23.976

If pull-down is detected in the source signal, and the "Detect Pull-down" option (page 55) is selected, the V4HD displays the cadence in the signal path display as shown in Figure 6-18:

Figure 6-18: Pull-down detection.

TABBED SETTINGS

Use the *tabs* (Figure 6-1) to view settings for each tab in the lower right area of the window. Each tab is discussed in the following sections.

SETUP

The *Setup* tab (Figure 6-19) has the following settings.

Auto Detect Input Format

The *Auto Detect Input Format* option (Figure 6-19) lets you choose the degree to which the V4HD will automatically detect the video format for the input currently chosen in the *Video Source* menu (Figure 6-3).

Manual

Choose *Manual* to specify the format by hand from the HD and SD output format menus in the signal path diagram.

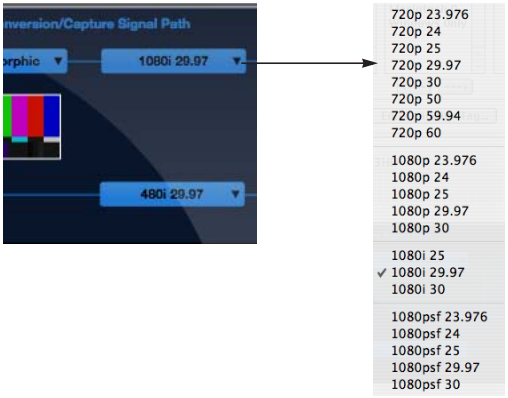


Figure 6-20: Manually specifying the input format.

Most of the time, you will probably use the *Genlock* and *Format and Genlock* modes discussed below, which automatically detect the incoming video signal. However, there may be times when it is useful for you to be able to manually determine format. For example, if you are feeding a compromised video signal to the V4HD, setting the format manually might produce the best results in terms of capturing the degraded signal, as the V4HD may be able to better maintain genlock.

Manual Refresh button

When you choose *Manual* mode from the Auto Detect Input Formant menu, the Manual Refresh button appears in the Setup tab (Figure 6-21). Click this button to force the V4HD to relock to the incoming video signal. This may be necessary after restarting the signal, swapping cables, etc.

Figure 6-21: Manual Refresh button.

Genlock

The *Genlock* option causes the V4HD to automatically genlock to the incoming video signal, but you can still specify the video format, according to what makes sense, given the genlocked signal. For example, there is no way for the V4HD to differentiate 1080i29.97 input from

Figure 6-19: The Setup tab settings.

1080PsF29.97 input. The signals are identical but will be interpreted differently by the V4HD's down converter, so in a case like this, you can choose Genlock and then specify the incoming format manually in the HD and SD Output Format menus (Figure 6-3), as explained in "SD/HD output format" on page 46.

Format and Genlock
The *Format and Genlock* option (Figure 6-19) causes the V4HD to fully detect both genlock and the video format for the current video source.

SDI Output Timecode Format

Use the *SDI Output Timecode Format* menu (Figure 6-19) to specify the form of embedded time code to include in the V4HD SDI output signal. Choices are *LTC*, *VITC 1* and *VITC 2*.

480i Component Analog Format

The *480i Component Analog Format* option lets you specify the voltage level standard for the V4HD's SD component inputs and outputs when running at 480i (NTSC). Choices are: EBU N10, Sony Beta, Sony Beta Japan and Panasonic MII. Choose the format that best matches the device(s) connected to the SD component input and output.

Full Raster mode

The V4HD goes into Full Raster mode when you specify Apple ProRes as the video format for your Final Cut Pro project. More specifically, the V4HD goes into Full Raster mode when you choose a ProRes sequence, capture or playback preset, or when you specify V4HD (or MOTU) Full Raster for video input or output (as demonstrated in Figure 7-4 on page 60). When you are working with full-raster video, make sure the *Full Raster mode* (Figure 6-19) matches the FireWire connection you are using between the V4HD and the computer.

FireWire 800 HQ
If you are using FireWire B, choose the *FireWire 800 HQ* setting. This option is only present in the menu when the V4HD is connected to the Mac via FireWire B operating at 800 Mb/s. It is not available when FireWire A (400) is being used. This option produces the best possible video quality for full raster capture and playback with ProRes or any other other high-quality HD codec with compression characteristics similar to ProRes HQ (a compression ratio of approximately 6:1).

FireWire 400 HQ
If you are using a FireWire A connection, choose *FireWire 400 HQ*. This setting provides high-quality full raster video capture and playback over a FireWire A, along with at least eight channels of 48 kHz audio. This setting produces the best possible video quality when circumstances require the use of a FireWire 400 (FireWire A) connection. This setting is also permitted when using FireWire 800, and could be used to free up FireWire bandwidth for other daisy-chained devices or additional banks of audio.

FireWire 400
The *FireWire 400* setting is similar to the *FireWire 400 HQ* setting above, except that it allows for up to three 8-channel banks of 48 kHz audio (or one 8-channel bank of 96 kHz audio) over a FireWire 400 connection.

Timecode Source

The *Timecode Source* menu (Figure 6-19) lets you specify which time code source you would like the V4HD to resolve to: *Sony 9-pin* (via the RS-422 port), the *LTC* jack on the rear panel of the V4HD, *SDI* (embedded) time code from the SDI input currently chosen in the Video Source menu (Figure 6-3 on page 43), or *SD VITC* (vertical interval time code) from the currently chosen SD source input.

480i Setup

The *480i Setup* option (Figure 6-19) lets you choose between *USA (7.5%)* and *Japan (0.0%)* for NTSC composite and S-video input and output.

Timecode Destination

The *Timecode Destination* menu (Figure 6-19) lets you specify the video destination for timecode generated or regenerated by the V4HD. You can choose *None*, *SD VITC* (vertical interval time code), *SD-SDI* or *HD-SDI*. For the SDI options, the time code is encoded as standard embedded time code in the chosen SDI stream. This setting also determines the time code format to be transmitted from the V4HD's LTC output jack on the rear panel. For example, if you choose SD-SDI, then the LTC output will generate pull-down time code aligned to the SD outputs. This distinction is important, for instance, when converting 23.976 fps HD video to 29.97 fps SD video. In this case, this setting determines whether the LTC output consists of 30 frame or 24 frame timecode.

Enable Video

The *Enable Video* option (Figure 6-19) enables or disables all of the V4HD's video features. When they are disabled, the V4HD operates as a 24-channel audio interface and mixer, or as a stand-alone mixer. Disabling the video features also allows you to resolve the V4HD to another digital audio device via its word clock input, AES/EBU input or ADAT optical input. See "Syncing digital audio devices" on page 29.

Playback Only (disable inputs)

The *Playback Only (disable inputs)* option (Figure 6-19) lets you disable the video inputs on the V4HD. When this option is enabled, the FireWire capture portion of the signal path (Figure 6-3) disappears, as no capturing or converting is possible. This mode is useful at times during your workflow when you are playing back video from your host software (during editing, etc.) but you are not actively capturing or converting. For example, this mode is recommended when you have no video inputs connected to the V4HD.

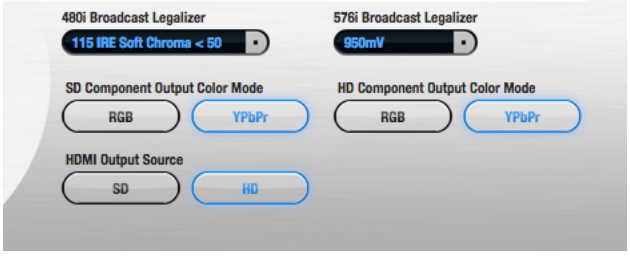


Figure 6-22: The Output tab settings.

OUTPUT

The *Output* tab (Figure 6-22) provides settings for the V4HD video outputs.

480i Broadcast Legalizer

Video with highly saturated colors may result in a composite signal which is too "hot" to broadcast. The *480i Broadcast Legalizer* menu (Figure 6-22, Figure 6-23) controls the V4HD's SD Broadcast Legalizer module, which desaturates any overly saturated pixels to bring the composite signal within the specified limit. For example, selecting *120 IRE* guarantees the output will never exceed 120 IRE units. Only pixels that exceed the chosen limit are affected and brought within range.

The *Soft* options provide a more gentle slope to the filter, adjusting pixels above and below the chosen limit to produce better results, but in the end still capping all pixels to the chosen limit.

Composite video consists of both a *chroma* and a *luma* component. The *< 50* options further restrict V4HD composite output by ensuring that the chroma does not exceed 50 IRE units.

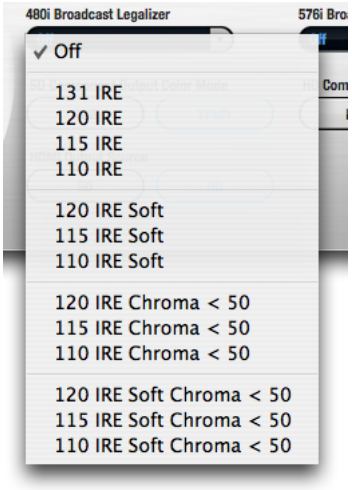


Figure 6-23: 480i Broadcast Legalizer menu.

576i Broadcast Legalizer

The *576i Broadcast Legalizer* menu (Figure 6-22, Figure 6-24) controls limiting the PAL composite output in a similar manner as discussed above for NTSC composite output, except that the levels for PAL are expressed in millivolts (mV).

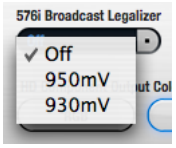


Figure 6-24: 576i Broadcast Legalizer menu.

SD Component Output Color Mode

Choose either the *RGB* or *YPbPr* color space (Figure 6-22) for SD Component output.

HD Component Output Color Mode

Choose either the *RGB* or *YPbPr* color space (Figure 6-22) for HD Component output.

HDMI Output Source

The V4HD always outputs both SD and HD video signals, converting the currently chosen source as necessary to produce both formats simultaneously. The V4HD's HDMI output jack can output either the HD or SD signal. Use the *HDMI Output Source* setting (Figure 6-22) to choose SD or HD for the HDMI output. For example, if you choose SD, the HDMI output destination in the signal path diagram connects to the SD path as shown below (Figure 6-25):

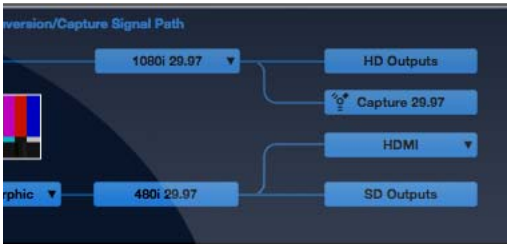


Figure 6-25: Sending SD video to the HDMI output.

PREVIEW

The *Preview* tab (Figure 6-26) lets you preview the video signal being received from the currently selected input in the Video Source menu (Figure 6-3). Choose the desired Preview Format (SD or HD) from the menu provided. If up conversion or down conversion is being applied, the "Format Conversion menu" on page 44 determines how the signal is formatted within the preview frame.

If you don't see the source video signal

If you have trouble getting the source video signal to appear in the preview frame, try checking the "Auto Detect Input Format" setting in the Setup tab (Figure 6-19) and make sure it is set to *Format and Genlock*. Also check the Genlock LED (Figure 6-1).

The Preview tab and Final Cut Pro

Final Cut Pro takes over the V4HD hardware when it is the front-most (active) application. MOTU Video Setup does the same. Therefore, the preview window only works when MOTU Video Setup is active. In this case, Final Cut Pro releases the V4HD hardware, so you won't be able to capture or play anything in Final Cut Pro while MOTU Video Setup is the active application.

To reestablish communication with Final Cut Pro, simply switch back into Final Cut Pro.

Codec Missing

If you see a *Codec Missing* message in the Preview frame, this means that MOTU Video Setup cannot find a software component required to display the incoming video format. Compatible codecs are installed with Final Cut Pro.

Figure 6-26: The Preview tab settings.

PLAYBACK

The *Playback* tab (Figure 6-27) provides settings that apply to video playback from Final Cut Pro (as opposed to capturing). Therefore, these settings relate to the current settings in Final Cut and its timeline.

The playback signal path

When you click the Playback tab, the signal path diagram displays settings for playback from Final Cut Pro, as explained earlier in "Playback signal path" on page 42.

Playback Clock Source

In Capture or Convert modes, the V4HD resolves to the video signal being received from the currently chosen input in the *Video Source* menu (Figure 6-3 and Figure 6-5).

In Playback mode, you can specify the timing reference for the V4HD in the *Playback Clock Source* menu (Figure 6-27). Four choices are provided.

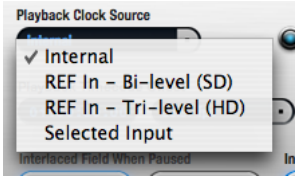


Figure 6-28: Playback Clock Source menu.

Internal

Choose *Internal* (Figure 6-28) to make the V4HD resolve to its own internal clock. This setting is best when you do not need to resolve the V4HD to house sync (blackburst).

REF in — Bi-level (SD)

Choose *REF in — Bi-level (SD)* (Figure 6-28) when you wish to resolve the V4HD to an SD clock source connected to its VIDEO REF input on the rear panel. Use this setting to resolve the V4HD to house sync (blackburst).

REF in — Tri-level (HD)

Choose *REF in — Tri-level (HD)* (Figure 6-28) when you wish to resolve the V4HD to an HD clock source connected to its VIDEO REF input on the rear panel.

Selected Input

Choose *Selected Input* (Figure 6-28) when you wish to resolve the V4HD to the video signal being received from the currently chosen input in the *Video Source* menu (Figure 6-3 and Figure 6-5), even though the V4HD is currently in *Playback* mode and you are not capturing or converting the source video signal.

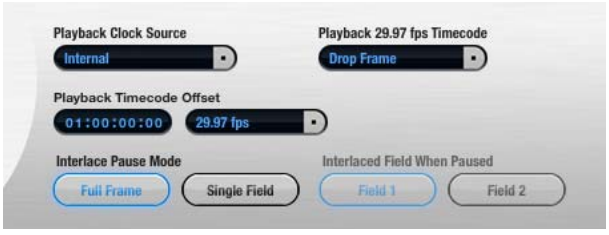


Figure 6-27: The Playback tab settings.

Playback 29.97 fps Timecode

If your Final Cut Pro time line is currently set to the 29.97 drop-frame format, choose *Drop Frame* from the *Playback 29.97 fps Timecode* menu (Figure 6-27) so that the V4HD matches Final Cut's frame format. If Final Cut is running 29.97 non-drop, choose *Non-Drop Frame*. (If you are running Final Cut at any other frame rate besides 29.97, this setting is ignored.)

Playback Timecode Offset

The *Playback Timecode Offset* options (Figure 6-27) let you specify the frame format and timecode offset for timecode generated by the V4HD during playback. Make sure these settings match their corresponding settings in your Final Cut Pro project, so that the V4HD generates timecode that matches Final Cut Pro's time line.

Interlace Pause Mode / Interlaced Field When Paused

If you are working with an interlaced video format, the *Interlace Pause Mode* (Figure 6-27) lets you choose between viewing a full frame or individual fields when Final Cut Pro parks on a frame. If you choose the *Single Field* option, the *Interlaced Field When Paused* options let you specify the video field you wish to see. When the *Interlace Pause Mode* option is set to *Full Frame*, the *Field 1* and *Field 2* options are grayed out. Clicking on these buttons will not bring the MOTU Video Setup application to the front, so you can switch between fields, or between Full Frame and Single Fields modes, while Final Cut Pro is the front application.

CONVERT

The *Convert* tab (Figure 6-29) provides two settings for SD to HD up conversion during capture or playback.

Upconversion Deinterlacing

When an SD video signal is upconverted to HD, it must be deinterlaced (and, depending on the HD format you are working with, re-interlaced). The V4HD provides three different settings for deinterlacing to provide the best possible results for various types of video material. You can, of course, experiment with the three options to find which one produces the best-looking results.

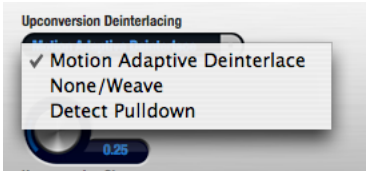


Figure 6-30: Upconversion deinterlacing.

Motion Adaptive Deinterlacing

As its name implies, the *Motion Adaptive Deinterlacing* option (Figure 6-30) provides good results for most standard interlaced SD video material, including material with a lot of vertical and horizontal motion in it. If the source footage is relatively static, you could also try the *None/Weave* option below.

Figure 6-29: The Convert tab settings.

None/Weave
The *None/Weave* option (Figure 6-30) is the simplest algorithm, with no processing or advanced frame/field detection. Instead, it "weaves" each pair of fields together, treating them as a progressive frame. This option is best for material that shouldn't really be treated as interlaced, such as SD footage shot in non-standard, progressive recording modes, such as the"30p" mode found on some cameras.

Detect Pull-down
Use the *Detect Pull-down* option (Figure 6-30) if the source footage already has either 2:3 or 2:3:3:2 pull-down inserted (due to a telecine transfer, the "24p" record mode of some cameras, etc.) The V4HD will auto-detect the cadence of the pull-down and assemble frames accordingly.

Upconversion deinterlacing and 23.976 frame rates
The Upconversion Deinterlacing mode is ignored if the HD frame rate is 23.976. In this case, the V4HD attempts to detect and remove pull-down.

Upconversion Sharpness
Adjust *Upconversion Sharpness* (Figure 6-29) to further improve the deinterlaced HD image. This control determines the amount (in arbitrary units from 0.00 to 1.00) of an unsharp mask applied to the image while upconverting.

INPUT
The *Input* tab (Figure 6-31) provides several settings for adjusting the *Brightness*, *Contrast* and *Hue* of the incoming Composite or S-Video (SD) signal.

THE GENLOCK LED
The genlock LED (Figure 6-1) indicates when the V4HD has successfully genlocked to one of the following sources:

- the video signal being received from the currently chosen input in the *Video Source* menu (Figure 6-3 and Figure 6-5)
- the Playback Clock Source (Figure 6-27 and Figure 6-28)
- the Video REF input (see "Video sync connections" on page 27)

If the Auto Detect Input Format option (page 48) is set to *Manual*, the genlock LED will always be illuminated.

THE DEVICES MENU
The Devices menu provides a shortcut for launching the MOTU Audio Setup application. If you have multiple MOTU video interfaces connected, it also lets you choose which interface you are currently controlling with the MOTU Video Setup software.

Figure 6-31: The Input tab settings.

CHAPTER 7 Final Cut Pro

OVERVIEW

The V4HD serves as a powerful video capture and playback device for Apple Final Cut Pro. Operation is straightforward and follows the general workflow prescribed by Final Cut Pro. In addition to standard log and capture procedures and straightforward timeline playback, the V4HD also provides presets for Easy Setup, Sequences, Capture and Device Control.

The V4HD supports full-raster HD capture to Apple ProRes or any other similar HD codec of your choice. It also provides hardware-accelerated capture directly to DVCPro, DVCPro50 and DVCProHD.

FAMILIARITY WITH FINAL CUT PRO

This chapter assumes that you have a working knowledge of basic Final Cut Pro operation.

BEFORE YOU LAUNCH FINAL CUT PRO

Before you launch Final Cut Pro, be sure to:

- Insert the V4HD Installer CD and run the Easy Install option.
- Connect the V4HD to the computer via a single FireWire connection and connect your video devices to it as explained in chapter 3, "Installing the V4HD Hardware" (page 19).
- Switch on the V4HD and run MOTU Video Setup to make sure that installation has been successful. If MOTU Video Setup launches without any error messages, then Final Cut Pro should successfully communicate with the V4HD.

GETTING STARTED

You are now ready to run Final Cut Pro.

1 Launch Final Cut Pro.

2 Create a new project using Final Cut Pro's Easy Setup feature in the Final Cut Pro menu. See the next section for details about Easy Setups.

Figure 7-1: The V4HD ships with over 60 Easy Setups for the many formats and operating scenarios it supports.

EASY SETUPS

There are five settings in Final Cut Pro that directly impact V4HD operation:

- Sequence preset
- Capture preset
- Device Control Preset
- Video Playback
- Audio Playback

Easy Setup (Figure 7-1) is a convenient way to universally configure all of these settings according to the video format you have chosen for your Final Cut Pro project. Once you've chosen a V4HD Easy Setup, you can modify it as needed in Final Cut Pro's *Audio/Video Settings* window (Figure 7-2).

FINAL CUT PRO AUDIO/VIDEO SETTINGS

To set up Final Cut Pro manually, without using an Easy Setup, or to adjust the settings for an Easy Setup, simply go to Final Cut Pro's *Audio/Video Settings* window (Figure 7-2) and individually select the V4HD's capture, device control and sequence presets. The V4HD presets are identified by either *V4HD* or *MOTU* in their name. If you don't see a preset for the capture or playback scenario you need, this doesn't necessarily mean it's not supported. It probably is, and you can create your own. See "Supported conversions" on page 63 and "Creating your own capture/playback presets" on page 64.

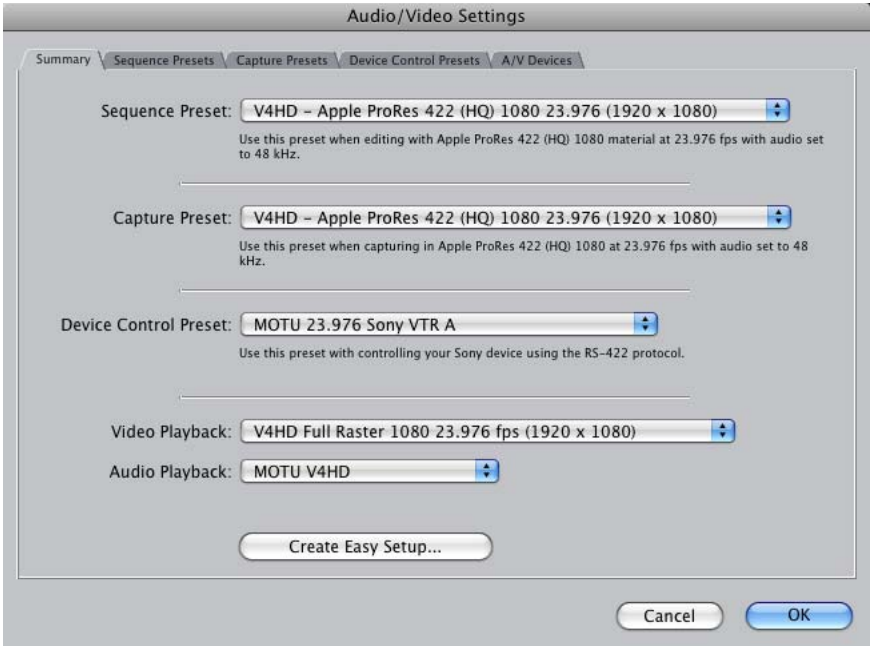


Figure 7-2: V4HD Easy Setup settings can be adjusted in Final Cut Pro's Audio/Video Settings window.

CHOOSING A WORKFLOW

The V4HD supports a range of SD and HD workflows, summarized in Figure 7-3 below. The V4HD supports every workflow via FireWire 400 or 800, although Apple ProRes 422 HQ should be used with a FireWire 800 connection whenever possible. For uncompressed SD, all DVCPro formats and Apple ProRes, the V4HD provides sequence and capture presets for all supported format/frame rate/codec combinations. Other codecs require that you make your own custom sequence settings. Refer to the following sections for further information regarding each workflow. Also see "Video encoding and CPU performance during capture" on page 61.

Uncompressed SD

The V4HD supports both 8-bit and 10-bit uncompressed SD capture and playback via FireWire 400 or 800. Both NTSC and PAL formats are supported, as well as 480p 23.976. Choose the sequence preset and capture preset that corresponds with the format you need to capture, edit and play back.

DVCPro25 / DVCPro50 / DVCProHD

The V4HD provides hardware-accelerated DVCPro25, DVCPro50 or DVCProHD capture and playback over FireWire 400 or 800. The V4HD hardware performs DVCPro compression during capture and decompression during playback. Video streams over FireWire to and from the computer as a compressed DVCPro video stream. Choose the sequence and capture presets that correspond with the video format, frame rate and DVCPro format you need to capture, edit and play back.

Apple ProRes 422

The V4HD provides hardware-assisted Apple ProRes 422 capture and playback over FireWire 400 or 800. When capturing ProRes, Final Cut Pro requires an Intel-based multi-processor Mac, and four or more processor cores are recommended. For ProRes operation, be sure to choose the *V4HD Full raster* presets (for the sequence, capturing and playback) that correspond with the video format and frame rate you are working with. For the best possible video quality, set the V4HD's *Full Raster mode* (Figure 6-19 on page 48) to *FireWire 800 HQ*. This setting requires a FireWire 800 connection between the V4HD and the Mac. See "Full Raster mode" on page 49 for further information. If your computer experiences performance issues during capture or playback, or if circumstances do not allow for a FireWire 800 connection, you can use the *FireWire 400* settings with excellent results, especially for ProRes standard quality workflows.

Workflow	FireWire support	Sequence preset	Capture preset	Full raster setting
Uncompressed SD	400 or 800	V4HD - Uncompressed	V4HD - Uncompressed	N/A
DVCPro25 / DVCPro50	400 or 800	V4HD - DVCPro / DVCPro50	V4HD - DVCPro / DVCPro50	N/A
DVCProHD	400 or 800	V4HD - DVCProHD	V4HD - DVCProHD	N/A
Apple ProRes 422 standard	400 or 800	V4HD - Apple ProRes 422	V4HD - Full raster	*FireWire 800 HQ* recommended
Apple ProRes 422 HQ	800 only	V4HD - Apple ProRes 422 (HQ)	V4HD - Full raster	*FireWire 800 HQ* recommended
Other codec	400 or 800	Custom	V4HD - Full raster	*FireWire 800 HQ* recommended

Figure 7-3: The V4HD supports these workflows with Final Cut Pro.

Other codecs

The V4HD provides hardware-assisted capture and playback over FireWire 400 or 800 for any HD codec supported by Final Cut Pro. The V4HD is optimized for codecs that are similar in nature to ProRes HQ (around a 6:1 compression ratio or higher). To specify a codec other than ProRes or DVCProHD, choose the V4HD Apple ProRes preset that most closely matches the video format and frame rate you wish to use, duplicate it and then simply modify the duplicate preset, choosing a different codec from the *Compressor* menu (Figure 7-4). For further details about creating your own presets, see "Creating your own capture/playback presets" on page 64 and "Supported conversions" on page 63.

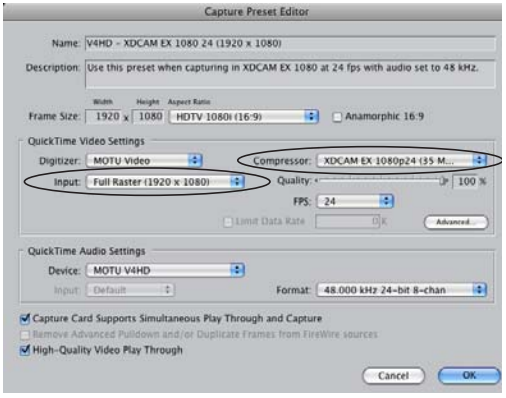


Figure 7-4: Specifying an HD codec. Be sure the Input menu is set to 'Full Raster' (either 1920 x 1080 or 1280 x 720).

Be sure to choose the *V4HD Full raster* capture preset that corresponds with the video format and frame rate you are working with. Like ProRes HQ, best quality can be achieved over FireWire 800 with the *Full Raster mode* option (Figure 6-19 on page 48) set to *FireWire 800 HQ* (page 49). A four- or eight-core Intel Mac may also be required, depending on the performance of the HD codec. However, excellent results can also be achieved over FireWire 400 with other codecs that have a compression ratio similar to (or higher than) ProRes standard mode (around 140 Mb/s).

V4HD HARDWARE SETTINGS

Once you've chosen a workflow and the corresponding presets in Final Cut Pro's Easy Setup and Audio/Video Settings windows (Figure 7-1 and Figure 7-2), open the MOTU Video Setup application (Figure 6-1 on page 41) to view the V4HD's hardware settings and make any adjustments, if necessary.

Capture settings

To access the V4HD's capture settings, click the Setup tab to view the Capture Signal Path (Figure 6-3 on page 43) and Setup tab settings (Figure 6-19 on page 48). In the Setup tab, make sure that the *Enable video* option is enabled and the *Playback only (disable inputs)* option is disabled.

Choosing a video input

To specify the video input for capture, choose the desired V4HD video input from the *Video Source* menu (Figure 6-3 on page 43).

Other capture settings

To make the V4HD automatically detect the format of the currently selected video input in the source menu, choose *Format and Genlock* from the *Auto Detect Input Format* menu.

If you will be up converting in the V4HD hardware while capturing, click the Convert tab (Figure 6-29 on page 54) and set the desired deinterlacing mode.

For details on other Capture settings, review Chapter 6, "MOTU Video Setup" (page 41).

Playback settings

Click the Playback tab to view the Playback Signal Path (Figure 6-2 on page 42) and Playback tab settings (Figure 6-27 on page 53).

In the Playback Signal Path (Figure 6-2 on page 42), the *Playback settings* menu displays the video format you've chosen in Final Cut Pro for

your sequence. When Final Cut Pro is running, this menu cannot be changed, as the playback format is specified by your settings in Final Cut Pro.

In the Playback tab, make sure the *Playback Timecode Offset* and frame rate match your Final Cut Pro sequence offset and frame rate. If you are working with drop frame time code, be sure to choose *Drop frame* from the *Playback 29.97 fps Timecode* menu (Figure 6-27 on page 53).

If you want Final Cut Pro to resolve to an external sync source during playback, choose the desired source from the *Playback Clock Source* menu (Figure 6-28 on page 53); otherwise, leave it set to *Internal*.

For interlaced output from the V4HD, use the *Interlace Pause Mode* options (Figure 6-27) to determine what you'll see when Final Cut Pro is paused.

If you are at a point in your workflow where you are not capturing video, or if you have no video inputs connected to the V4HD, click the Setup tab and enable the *Playback only (disable inputs)* option Figure 6-19 on page 48.

For details on other playback settings, review Chapter 6, "MOTU Video Setup" (page 41).

LOG AND CAPTURE

Once you've decided on a workflow, chosen the corresponding Easy Setup preset for your Final Cut Pro project and specified the video input you wish to capture in MOTU Video Setup, you are ready to log and capture video from the V4HD:

1 Make sure that the V4HD's *Playback Only* option (Figure 6-19) in MOTU Video Setup is disabled. See "Playback Only (disable inputs)" on page 50.

2 Choose Log and Capture from the File menu.

Figure 7-5: The Capture Settings tab with V4HD device control and codecs chosen.

3 Click the *Capture Settings* tab (Figure 7-5) and check the *Device Control* and *Capture/Input* settings.

These two settings are pre-configured if you created your Final Cut Pro project using a V4HD Easy Setup.

4 Click the *Now* button to start the capture.

Refer to Part IV of the Final Cut Pro manual for more information on advanced capture settings (such as batch capture, logging, etc.)

Figure 7-6: Click the 'Now' button to begin capture.

Video encoding and CPU performance during capture

If you are capturing uncompressed SD, the uncompressed video stream goes straight to your hard drive, with no compression or encoding required along the way.

When capturing any form of DVCPro (DVCPro25, DVCPro50 or DVCProHD), the V4HD hardware does the work of compressing the incoming (uncompressed) video stream into DVCPro. The V4HD then sends the DVCPro stream over FireWire to Final Cut, which streams it directly to the hard drive, with no further encoding necessary on the computer. In this scenario, there is no additional computer CPU overhead due to video compression or encoding, since none is required by the time the video stream reaches the computer.

When you are capturing Apple ProRes 422, Final Cut Pro performs the encoding in real time during capture. Given today's Intel processor speeds, ProRes requires approximately one Intel CPU core to perform this task, depending on the ProRes quality mode (standard or HQ), the speed of the processors, and other related factors. Your performance will vary, but generally speaking, ProRes 422 standard quality capture requires a computer with at least two Intel core processors; four cores or more are recommended. ProRes 422 HQ quality requires a computer with four Intel cores or more.

If you have chosen to capture to an HD codec other than DVCPro or Apple ProRes, the situation is similar to ProRes capture, described above. Final Cut Pro does the work of compressing the video stream, and so the computer's CPU performance must be good enough to handle the real-time encoding. Again, your performance will vary, depending on the codec you have chosen, core processor speeds, etc. If you have a four- or eight-core machine, however, you should be able to readily capture in just about any format you wish.

PLAYBACK AND MONITORING

To play back your Final Cut Pro project and view it on any monitor or other device connected to the V4HD's video outputs:

1 Choose *View menu> External Video>* and make sure that the All Frames item (command-F12) is checked.

2 Start playback.

If you are at a point in your project workflow where you are no longer capturing clips, you might want to consider putting the V4HD in *Playback Only* mode (Figure 6-19) in MOTU Video Setup. See "Playback Only (disable inputs)" on page 50. In this mode, you can either run the V4HD under its own internal clock, or you can resolve the V4HD to an external clock source. See "Playback Clock Source" on page 53. Be sure to review the other settings in the Playback tab (page 53).

Video decoding and CPU performance during playback

If you are playing uncompressed SD from the Final Cut Pro timeline, the uncompressed video stream goes straight to the V4HD, with no compression or encoding required along the way.

When playing back any form of DVCPro (DVCPro25, DVCPro50 or DVCProHD), the V4HD hardware does the work of decompressing the outgoing DVCPro video stream into uncompressed video for output to its HD-SDI, HDMI and HD component outputs. In this scenario, there is no additional computer CPU overhead required for video decompression or transcoding, since none is required to transmit the DVCPro stream from the computer to the V4HD.

When you play back an Apple ProRes 422 Final Cut Pro sequence, or any other codec, Final Cut Pro performs real-time transcoding. Given today's Intel processor speeds, ProRes requires approximately one Intel CPU core to perform this task, depending on the ProRes quality mode (standard or HQ), the speed of the processors, and other related factors. Your performance will vary, but generally speaking, ProRes 422 standard quality playback requires a computer with at least two Intel core processors; four cores or more are recommended. ProRes 422 HQ quality requires a computer with four Intel cores or more.

When you play back a Final Cut Pro timeline with an HD codec other than DVCPro or Apple ProRes, the situation is similar to ProRes playback, described above. Final Cut Pro does the work of transcoding the video stream, and so the computer's CPU performance must be good enough to handle the real-time transcoding. Again, your performance will vary, depending on the

codec you have chosen, core processor speeds, etc. If you have a four- or eight-core machine, however, you should be able to play back just about any video format you wish.

HARDWARE CONVERSION DURING CAPTURE OR PLAYBACK

The V4HD provides hardware-based conversion features, which you can employ during capture or playback in Final Cut Pro. Here are a few examples:

- During log and capture, you could up-convert SD to HD in the V4HD hardware and then capture it in Final Cut Pro as HD. Or you could down-convert HD to SD and capture as SD.
- If you are capturing or playing back 23.976 fps source material, you could insert pull-down to 29.97 during capture or playback.
- As demonstrated below in Figure 7-7, you could play back 480p 23.976 material from Final Cut Pro and view it on SD monitors with pull-down inserted by the V4HD hardware on output. At the same time, you could also be converting it to 720p or 1080p 23.976 with 14:9 pillar box formatting.

These are just a few examples. There are hundreds of possible conversion scenarios. The following table shows a summary of where to manage conversion settings:

Hardware conversion during...	Final Cut Pro settings	V4HD settings
Playback	Video Playback menu in Audio/ Video settings window (Figure 7-2)	Playback Signal Path (Figure 6-2) and Convert tab (Figure 6-29)
Capture	Capture Preset menu in Audio/ Video settings window (Figure 7-2)	Convert/Capture Signal Path (Figure 6-3) and Convert tab (Figure 6-29)

Supported conversions

In general, the menus in the Playback and Capture Signal Path diagrams provide all applicable settings that are supported for any given conversion scenario. Here is a brief summary the forms of real-time, hardware conversion supported (note that they can be often be combined, too, where applicable):

- SD to HD up conversion (from 480 or 576 to 720 or 1080)
- HD to SD down conversion (from 720 or 1080 to 480 or 576)
- Up/down conversion reformatting (letterbox, pillar box, full screen, anamorphic, etc.)
- 2:3 or 2:3:3:2 pull-down insertion or removal
- Deinterlacing and reinterlacing

Figure 7-7: An example of hardware conversion during playback. Final Cut Pro is playing back 480p23.976. The V4HD hardware is simultaneously inserting 2:3 pull-down for SD playback and converting to 1080p23.976 with 14:9 pillar box formatting for HD playback.

Conversions that are not supported

If the menus in the Playback Signal Path and Capture Signal Path diagrams don't provide the format you are looking for, it means that this form of conversion either doesn't apply, or it is not supported by the V4HD video conversion hardware. For these forms of conversion, summarized below, use Final Cut Pro or Compressor to perform off line transcoding on the computer:

- HD to HD cross conversion — use transcoding to convert 720 to 1080 or vice versa
- Frame rate conversion — use transcoding to convert 29.97 fps to 30 fps (or vice versa), 23.976 fps to 24 fps, 59.94 fps to 60 fps, etc.
- Conversion from NTSC to PAL (or vice versa)
- Down conversion from 1080p 23.976 or 1080PsF 23.976 to NTSC while doing full raster capture or playback. (In this case, SD output is black.)

Creating your own capture/playback presets

If the capture or playback preset menus don't have the preset you are looking for, you can create your own presets, as long as they conform to the guidelines stated earlier in the "Supported conversions" section.

To create capture presets, go to the Audio/Video Settings window, click the Capture Presets tab (Figure 7-2), select an existing V4HD preset (it doesn't matter which one) and click the *Duplicate* button. Modify the settings as desired. If you intend to choose a non-V4HD codec, see "Other codecs" on page 60.

The procedure for creating sequence/playback presets (in the Sequence Presets tab) is similar.

V4HD AUDIO SETTINGS

To access basic V4HD audio settings:

1 Choose *Final Cut Pro menu> Audio/Video Settings.*

2 Select the *A/V Devices* tab.

3 Choose the V4HD for audio playback.

4 Click the *Options* button to set the number of channels, sample rate, etc. These settings will modify the V4HD hardware so that it matches the setting in Final Cut Pro.

You can verify the V4HD's audio settings using MOTU Audio Setup (Figure 8-1 on page 72).

Choosing audio banks

The V4HD provides four 8-channel banks of simultaneous audio input and output. Each bank can be enabled or disabled. In Final Cut Pro, the V4HD's channels are simply numbered 1, 2, 3, 4, etc. How do Final Cut Pro's channel numbers correspond to the V4HD's enabled audio banks? The answer is the order of the 8-channel banks. The V4HD audio banks always go in the following order, from lowest channel number to highest:

1. Analog
2. AES/EBU
3. ADAT
4. Embedded (SDI/HDMI)

This is the order in which the banks appear in MOTU Audio Setup:

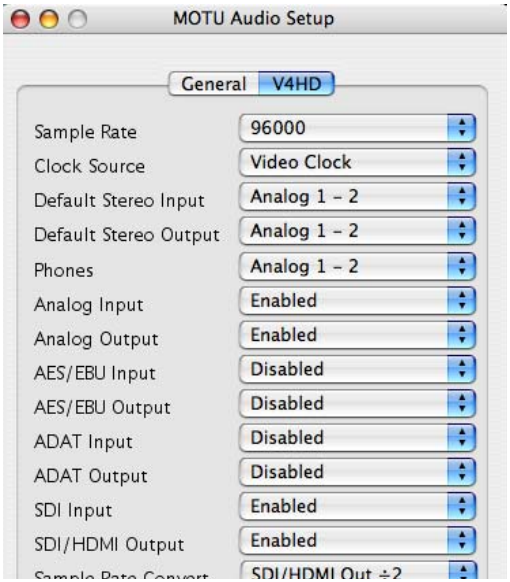


Figure 7-8: The top to bottom order of the audio banks listed in MOTU Audio Setup is how they are ordered in Final Cut Pro.

In the above example (Figure 7-8), the analog and SDI banks are enabled. This means that the V4HD will supply 16 channels of audio input and output to Final Cut Pro. Channels 1-8 are the analog ins and outs; channels 9-16 are the SDI ins and outs. If the AES/EBU bank is enabled, channels 9-16 would be the AES/EBU channels. It is a good idea to only enable the audio banks you are using.

AUDIO CAPTURE

To specify the audio inputs on the V4HD that you wish to capture from:

1 Enable and disable the V4HD's four audio banks as desired (Figure 7-8).

2 In Final Cut Pro's Log and capture window, click the *Clip Settings* tab.

Figure 7-9: Clip Settings tab.

The channels in the list (Figure 7-9) correspond to the V4HD audio banks currently enabled in MOTU Audio Setup (Figure 7-8), as explained earlier in "Choosing audio banks".

3 Use the arm/disarm buttons next to each channel number (Figure 7-9) to choose which V4HD audio inputs to record.

4 Disable the *Preview* check box in the Audio section (Figure 7-9).

The V4HD has extensive "CueMix" audio monitoring features, including delay compensation, so you are better off monitoring both audio and video through the V4HD hardware. See the following:

- Chapter 3, "Installing the V4HD Hardware" (page 19) for information about the necessary video and audio connections

■ Chapter 9, "CueMix FX" (page 79) for complete information about controlling CueMix monitoring

■ "Sync CueMix audio with video output" on page 77 and "Additional Audio Delay" on page 76 for details about managing audio latency for CueMix monitoring

AUDIO PLAYBACK

To play back audio:

1 Choose *View menu> Audio Playback> V4HD.*

2 In the Sequences window, select your sequence.

3 Choose *Sequence menu> Settings*.

4 Click the *Audio Outputs* tab and configure the outputs as needed. Consult your Final Cut Pro documentation for details.

5 Go to the Audio Mixer to assign each audio track to the desired V4HD audio output, or right-click on the *Toggle Auto Select* icon next to each audio track in the track Time Line window.

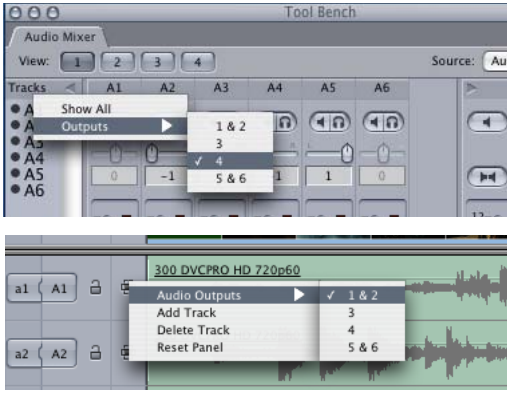


Figure 7-10: Assigning audio tracks to V4HD audio outputs.

See "Additional Audio Delay" on page 76 for details about compensating for the inherent delay in external monitors.

REFRESH A/V DEVICE

If you switch off the V4HD, or the connection with the hardware is disrupted for some reason, you can bring the V4HD back on line by choosing *View menu> Refresh A/V Devices*.

TIME CODE

To lock Final Cut Pro to time code during capture, go to the Setup tab (Figure 6-19 on page 48) in MOTU Video Setup and choose the *Timecode Source* (page 49).

To configure the time code format being output by the V4HD hardware while Final Cut Pro is playing back, go to the Playback tab (Figure 6-27 on page 53) in MOTU video Setup and choose the *Playback Clock Source* (page 53). Also check the following additional Playback tab settings:

■ *Playback 29.97 fps Timecode* (page 54)

■ *Playback Timecode Offset* (page 54)

DEVICE CONTROL

The V4HD Easy Install option installs device control presets for Final Cut Pro that are fine-tuned to work with a variety of formats during capture, edit to tape and print to video operations.

To configure V4HD RS-422 (Sony 9-pin) device control in Final Cut Pro:

1 Connect an RS-422 cable from V4HD to the video deck or other machine control device.

2 Make sure the video deck is configured properly for remote operation via RS-422 machine control.

3 In MOTU Video Setup, choose *Sony 9-Pin* from the Timecode Source menu (Figure 6-19), which is found in the *Setup* tab, or choose LTC if your deck is feeding timecode to the computer via the LTC input (instead of via 9-pin).

4 Back in Final Cut Pro, choose the device control preset that best suits your project and device. This setting can be accessed in the Audio/Video Settings window (Final Cut Pro menu) or in the Capture Settings tab in the Log and Capture window.

You can now use Final Cut Pro's transport features to control your deck. Consult the Final Cut Pro documentation for complete information about using machine control during capture, edit to tape and print to video operations.

FIREWIRE 400 BANDWIDTH

If you have connected the V4HD to the computer via the 400 Mb/sec FireWire A port (page 8), you may see a warning message (Figure 7-11):

Figure 7-11: FireWire bandwidth warning.

If you see this message, try the following:

- In MOTU Audio Setup (Figure 8-1 on page 72), choose a lower sample rate (such as 44.1 or 48 kHz).
- In MOTU Audio Setup (Figure 8-1 on page 72), disable audio banks that you are not using.
- Unplug your FireWire A connection to the computer and switch to a FireWire B connection.

FINAL CUT PRO VIDEO FORMATS

The V4HD can capture and play back the following video formats from Final Cut Pro:

SD

- Uncompressed 8-bit and 10-bit at 480p23.976, 480i29.97, 486i29.97 and 576i25
- DVCPro25 or DVCPro50 at 480p23.976, 480i29.97 and 576i25

Note: the V4HD supports 480p23.976 SD capture and playback with hardware pull-down insertion/removal.

HD

- Apple ProRes 422 in standard or HQ modes. Or any similar full-raster video format supported by Final Cut Pro with a 10-bit 4:2:2 color space and a compression ratio similar to ProRes (approximately 6:1 or greater).
- DVCProHD 720p at 720p23.976, 720p24, 720p25, 720p29.97, 720p30, 720p50, 720p 59.94 and 720p60
- DVCProHD 1080i50 (1440 x 1080 raster) and 1080i60 (1280 x 1080 raster) at all 1080i frame rates listed on page 107

The V4HD can capture and play back 1080i50 at 30 fps, which provides better resolution (1440 pixels wide) than 1080i60 (1280 pixels wide). However, files recorded in the 1080i50 format cannot be recorded or played by other DVCProHD devices, such as a DVCProHD compatible video deck or camera.

Part 3
Audio Operation

CHAPTER 8 MOTU Audio Setup

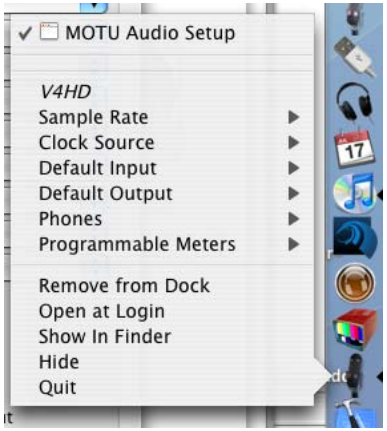
OVERVIEW

MOTU Audio Setup gives you access to basic V4HD audio settings, such as sample rate, clock source, optical format and more.

ACCESSING MOTU AUDIO SETUP

There are several ways to access MOTU Audio Setup settings:

- Click the MOTU Audio Setup icon in the dock
- Press on the MOTU Audio Setup dock icon to open the menu shown below, or control-click it to open the menu immediately



- From the front panel LCD as explained in chapter 12, "Front Panel LCD Programming" (page 95).

V4HD tab settings

The V4HD tab (Figure 8-1) provides settings that apply to a specific V4HD interface. If you have MOTU audio interfaces connected to your computer in addition to the V4HD, you'll see a separate tab for each interface.

General tab settings

The General tab (Figure 8-1) provides settings that apply globally to all connected MOTU interfaces.

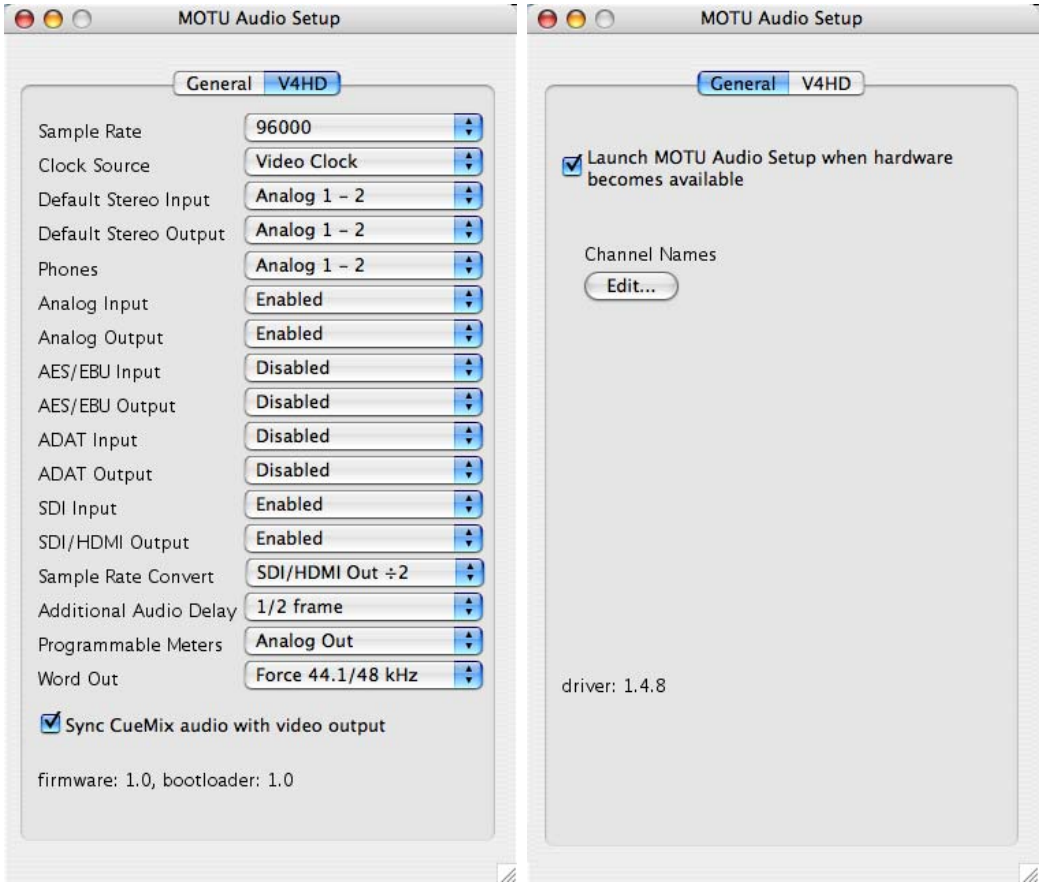


Figure 8-1: MOTU Audio Setup gives you access to all of the audio settings in the V4HD hardware.

V4HD TAB SETTINGS

Sample Rate

Choose the desired *Sample Rate* for recording and playback. The V4HD can operate at 44.1 (the standard rate for compact disc audio), 48, 88.2, 96, 176.4 or 192 kHz. Make absolutely sure that all of the devices connected digitally to the V4HD match the V4HD's sample rate.

☛ Mismatched sample rates cause distortion and crackling. If you hear this sort of thing, check the sample rate settings in your hardware and here in MOTU Audio Setup.

Operation at 4x sample rates (176.4 or 192kHz)

At the 4x sample rates (176.4 or 192kHz), operation of the V4HD audio features is restricted, due to the higher audio bandwidth demands, as follows:

- The V4HD provides 8 channels of analog input and 8 channels of analog output, simultaneously.
- Only one 8-channel digital input or output bank can be used, with sample rate conversion applied, because the digital I/O banks only operate up to 96 kHz. With sample rate conversion, you can either capture or play back digital audio via ADAT optical, AES/EBU, embedded SDI or embedded HDMI out at any sample rate from 44.1 kHz to 96 kHz.
- The headphone output is disabled.

Clock Source

The *Clock Source* determines what the V4HD will use as its time base for audio. The following sections briefly discuss each clock source setting.

Video Clock

When video is enabled (see "Enable Video" on page 50), the V4HD audio clock slaves to video, and this is the only choice in the Clock Source menu.

Internal

When video is disabled (see "Enable Video" on page 50), use the *Internal* setting when you want the V4HD to operate under its own digital audio clock. For example, you may be in a situation where all you are doing is playing audio from Final Cut Pro or audio software on the computer. In a situation like this, you most often don't need to reference an external clock of any kind.

ADAT optical

When video is disabled (see "Enable Video" on page 50), the *ADAT optical* clock source setting refers to the clock provided by the V4HD's optical input, when it is connected to an ADAT optical device. This setting can be used to slave the V4HD directly to the optical input connection. In this scenario, the *ADAT Optical* clock source setting lets you slave the V4HD to the other device via its digital connection to the V4HD.

☛ The V4HD has two pairs of optical connectors: a main pair (for 8-channel operation at 44.1 or 48 kHz) and an auxiliary pair (for channels 5-8 at 88.2 or 96 kHz). In ADAT optical clock mode, the V4HD always resolves to the optical input in the *main pair*, even during 88.2 or 96 kHz operation. So be sure to connect the ADAT optical clock master to the optical input in the main input connector.

If the *ADAT Optical* setting does not appear in the menu, it means that the V4HD's optical input is currently disabled. Choose *Enabled* from the ADAT input menu (Figure 8-1 on page 72).

For further details about this setting, see "Syncing digital audio devices" on page 29.

Word Clock In

When video is disabled (see "Enable Video" on page 50), the *Word Clock In* clock source setting refers to the Word Clock In BNC connector on the V4HD rear panel. Choosing this setting allows the

V4HD to slave to an external word clock source, such as the word clock output from a digital mixer or a digital audio interface.

AES/EBU
The *AES/EBU* clock source settings refer to the AES/EBU input pairs on the V4HD. This setting allows the V4HD to slave to another device connected to one of the V4HD's four AES/EBU input pairs when video is disabled (see "Enable Video" on page 50).

Use this setting whenever you are recording input from a DAT deck or other AES/EBU audio device into the V4HD. It is not necessary in the opposite direction (when you are transferring from the V4HD to the DAT machine).

If the *AES/EBU* settings do not appear in the menu, it means that the V4HD's AES/EBU input bank is currently disabled. Choose *Enabled* from the AES/EBU input menu (Figure 8-1 on page 72).

For further details about this setting, see "Syncing digital audio devices" on page 29.

SMPTE
When video is disabled (see "Enable Video" on page 50), choose the *SMPTE* clock source setting to resolve the V4HD directly to SMPTE time code (LTC) being received via the LTC input. For details, see chapter 10, "MOTU SMPTE Setup" (page 87).

Built-in audio
When video is disabled (see "Enable Video" on page 50), choose this setting to resolve the V4HD to your Mac's built-in audio. Doing so will ensure that audio streams playing back from or recorded by the V4HD will not drift apart from audio streams simultaneously played or recorded by the Mac's built-in mic, speakers or audio output.

Other audio devices (drivers)
When video is disabled (see "Enable Video" on page 50), the MOTU FireWire Audio Driver has the ability to resolve to other Core Audio drivers. Doing so will ensure that audio streams playing back from or recorded by the V4HD will not drift apart from audio streams simultaneously played or recorded by the other devices.

Default Stereo Input/Output

In the System Preferences window, Mac OS X lets you choose third-party hardware such as the V4HD for your Mac sound input and output. The system input and output can be used for alert sounds and general audio I/O for applications like iTunes, iMovie, etc.

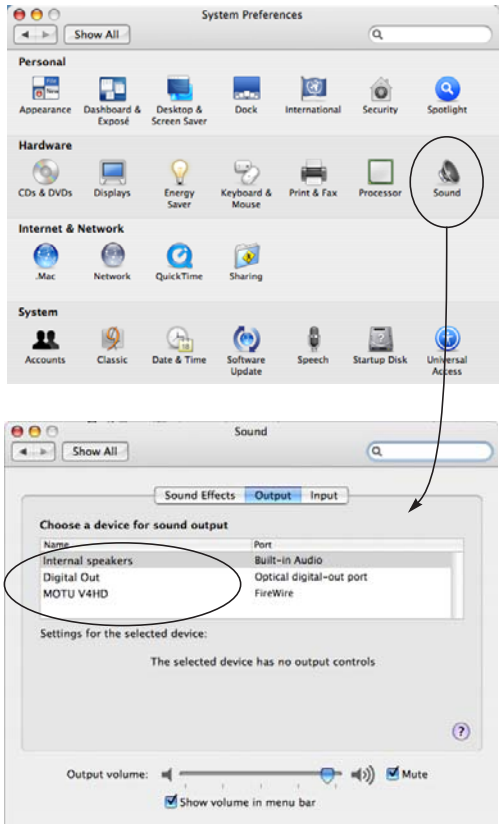


Figure 8-2: The Mac OS X sound preferences let you use the V4HD for general stereo audio input and output for your Mac.

The *Default Stereo Input* and *Default Stereo Output* settings in MOTU Audio Setup (Figure 8-1 on page 72) let you specify the stereo input and output on the V4HD to be used when it is chosen as the audio I/O device in the system preferences.

Phones

The *Phones* setting (Figure 8-1) lets you choose what you will hear from the headphone jack. For example, choose *Analog 1-2* if you'd like the headphone output to match the analog outputs 1 and 2.

Analog Input/Output

The *Analog Input/Output* menus (Figure 8-1) let you enable or disable the 8-channel analog bank. Enable a bank to make it available to Final Cut Pro or the V4HD's CueMix monitor mixer for audio input or output. Disable it if you are not using it to conserve FireWire bus bandwidth for video and other data. Note that input and output can be enabled or disabled independently.

AES/EBU Input/Output

The *AES/EBU Input/Output* menus (Figure 8-1) let you enable or disable the 8-channel bank of AES/EBU digital audio I/O, as described above for the analog banks.

ADAT Optical Input/Output

The *ADAT Input/Output* menus (Figure 8-1) let you enable or disable the 8-channel bank of ADAT optical digital audio I/O, as described above for the analog banks.

SDI Input and SDI/HDMI Output

These two menus (Figure 8-1) let you enable or disable the 8-channel bank of embedded digital audio I/O, as described above for the analog banks.

Sample Rate Convert

The Sample Rate Convert menu (Figure 8-1) lets you control the V4HD's sample rate conversion. Sample rate conversion can be applied to any 8-channel digital input or output bank, as explained below. The options in the menu change, depending on the V4HD's current Sample Rate setting (page 73). For example, if the V4HD is currently set to 192 kHz, you'll see "x 4" and "÷ 4" settings that don't apply to the lower sample rates.

When rate conversion is applied to a bank, the bank's rate conversion LED in the AUDIO STATUS section of the V4HD front panel (*src*) indicate that rate conversion is occurring.

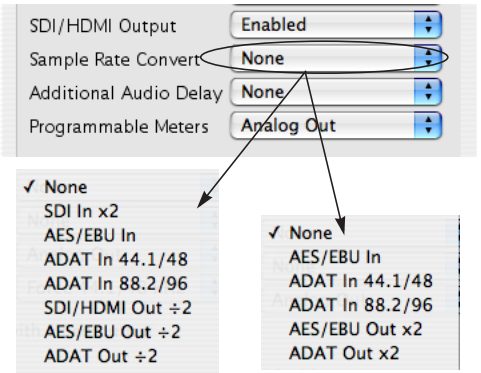


Figure 8-3: The Sample Rate Convert menu gives you access to a variety of input and output clock options.

None

No sample rate conversion occurs. Digital input and output match the sample rate of the V4HD's system clock.

AES/EBU In

The AES/EBU input locks to the sample rate of the input signal (whatever it happens to be) and converts it to the V4HD system clock rate.

x 2 / ÷ 2

Choose one of these sample rate conversion options when the rate for the chosen digital I/O bank needs to be twice the V4HD system clock rate or half the system clock rate. Either way, the digital I/O bank remains resolved to the V4HD system clock. For further details about this option, see "Syncing digital audio devices" on page 29.

x 4 / ÷ 4
Choose one of these sample rate conversion options when the rate for the chosen digital I/O bank needs to be four times the V4HD system clock rate or one quarter of the system clock rate. Either way, the digital I/O bank remains resolved to the V4HD system clock.

ADAT In 44.1/48 versus ADAT In 88.2/96
The V4HD provides two sets of ADAT optical digital I/O connectors, which together provide 8 channels at 44.1 or 48 kHz or 8 channels at 88.2 or 96 kHz. These options let you specify the sample rate being received by the V4HD on its optical input(s), from the other optical device. The received signal will then be sample rate converted to the V4HD's system clock rate, which can be any supported rate, even 176.4 or 192 kHz.

Additional Audio Delay

The *Additional Audio Delay* option (Figure 8-1) lets you add a certain amount of delay, specified in fractions of a video frame, to the V4HD's audio output.

The main purpose for this feature is to allow you to compensate for any inherent delay in a video monitor connected to the V4HD. For example, LCD displays often have a small delay in them — from the time they receive a video frame to the time at which they actually display it on their screen. Depending on how you are monitoring the accompanying audio signal, the audio will likely not have this same delay. As a result, the audio will be heard slightly ahead of the delayed video signal. This option lets you delay the audio signal by the same amount as the video display, so that audio and video are properly aligned with one another.

This option affects audio passing through the V4HD in two scenarios:

- Playback from Final Cut Pro
- V4HD CueMix monitoring

Playback from Final Cut Pro
The *Additional Audio Delay* option can be applied to audio being played back from Final Cut Pro to align it to Final Cut Pro's video output.

For example, let's say you are viewing Final Cut Pro output on a plasma monitor connected to one of the video outputs on the V4HD. This plasma monitor has an inherent one-frame delay (from the time it receives a frame to the time it displays it). In addition, you are listening to Final Cut Pro's audio output — in 5.1 surround — via studio monitors connected to the V4HD's analog audio outputs. Even though audio and video depart the V4HD outputs completely in sync with one another, the image on the plasma will be running one frame behind the audio you hear from the surround monitors. Use the Additional Audio Delay option (Figure 8-1) to delay the V4HD's audio output by one frame to match the image on the plasma.

V4HD CueMix monitoring
The *Sync CueMix audio with video output* option (shown in Figure 8-1 and described below) ensures that audio and video remain perfectly in sync with each other when they pass through the V4HD from its inputs to its outputs. However, you may still need to compensate for the inherent video signal delay in external devices connected to the V4HD. Therefore, when the *Sync CueMix audio with video output* option is checked, the *Additional Audio Delay* option can be applied for exactly that purpose.

For example, let's say you are capturing some SD footage from a camcorder connected to a V4HD SD video input, and you are monitoring it on an HD plasma monitor connected to an HD video output on the V4HD. This plasma monitor has an inherent one-frame delay (from the time it receives a frame to the time it displays it). In addition, the camcorder stereo audio output is connected to a pair of V4HD audio inputs, and you are listening to the camcorder's audio output via studio monitors

connected to the V4HD's analog audio outputs. Even though audio and video depart the V4HD outputs completely in sync with one another, the image on the plasma will be running one frame behind the audio you hear from the studio monitors. Use the Additional Audio Delay option (Figure 8-1) to delay the V4HD's audio output by one frame to match the image on the plasma.

Programmable Meters

This option lets you choose which bank you wish to monitor with the eight programmable meters on the V4HD front panel. Choices are: analog out (analog in has its own dedicated bank of meters), ADAT Optical in/out, AES/EBU in/out, SDI in and SDI/HDMI out.

Word Out

The *Word Out* menu (Figure 8-1) appears when the V4HD is operating at a 2x sample rate (88.2 or 96kHz) or 4x sample rate (176.4 or 192kHz). This menu lets you set the word clock output either to match the current sample rate (*System Clock*) or force it to the corresponding 1x rate (either 44.1 or 48kHz). For example, if the V4HD were operating at 176.4kHz, choosing the *Force 44.1/48kHz* option would produce word clock output at 44.1kHz.

Sync CueMix audio with video output

When the V4HD passes video and audio signal from its inputs to its outputs, there is a small delay in the video signal, while it is being processed and converted. Audio has almost no delay at all (less than a millisecond), which means that it will play a little bit ahead of the video signal. When you check the *Sync CueMix audio with video output* option (Figure 8-1), the V4HD precisely calculates the difference in the two signals (down to one audio sample) and delays the audio by exactly the correct number of samples to bring the audio signal back in sync with video when the two signals leave the V4HD outputs.

So, if the V4HD's CueMix audio doesn't sound in sync with the current video signal being monitored, try checking this option. If it still doesn't seem in sync, the most likely culprit is an inherent delay in your video monitor. The V4HD allows you to further compensate for external delay such as this. See "Additional Audio Delay" on page 76.

GENERAL TAB SETTINGS

Launch MOTU Audio Setup when hardware becomes available

Check this option if you would like the MOTU Audio Setup icon to appear in the application dock as soon as a MOTU interface is detected (switched on, plugged in, etc.)

Edit Channel Names

Click the *Edit Channel Names* button to open the Channel Names window (Figure 8-4). This window lets you edit the names of the V4HD inputs and outputs, as they might appear in your host software (if it supports channel names). For example, when you click on a menu that displays the V4HD inputs (or outputs), you will see the names you specify in this window (e.g. "camera input", "VTR input", etc.), instead of the default generic names ("Analog 1", "Analog 2", etc.)

☛ Not all Mac OS X audio software supports channel names. If not, you'll see generic port names in your host audio software, or no names at all.

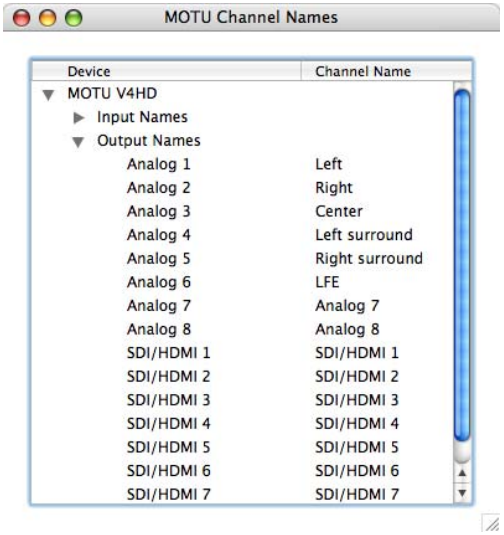


Figure 8-4: The Edit Channel Names window.

CHAPTER 9 CueMix FX

OVERVIEW

CueMix FX provides access to the flexible audio mixing and monitoring features of the V4HD, which are fully functional under video operation (capture, convert and playback) and the V4HD's audio only mode.

CueMix lets you route any combination of audio inputs to any stereo output pair. CueMix allows you to set up a separate mix configuration for every stereo output pair on the V4HD — a total of 16 stereo buses (or 4 stereo busses at 176.4 or 192 kHz). You can also save and load mix configurations.

CueMix monitoring can be set up to support your work in Final Cut Pro, or it can be set up independently of Final Cut Pro.

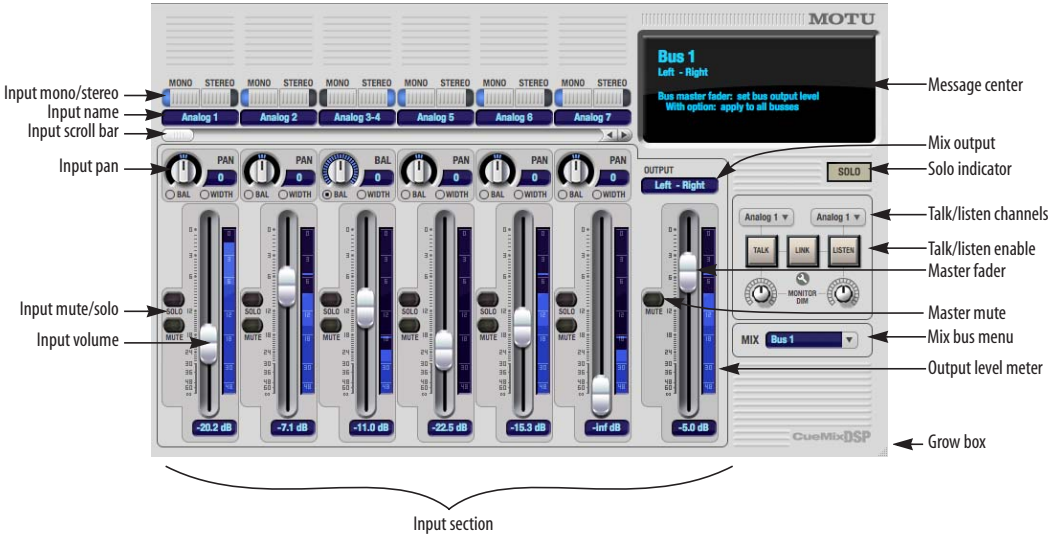


Figure 9-1: CueMix FX is a virtual mixer that gives you control over the V4HD's on-board mixing features.

CUEMIX MONITORING BENEFITS

CueMix FX provides several major benefits to your video post-production workflow:

- CueMix has no buffer latency. Thanks to the V4HD's hardware-based mixing, CueMix provides the same throughput performance as a digital mixer, so you can monitor audio as well as video during log and capture.
- CueMix imposes absolutely no processor drain on the computer's CPU.
- CueMix routing can be maintained independently of individual software applications or projects. So you can use it even when you are not working in Final Cut Pro.

CUEMIX FX INSTALLATION

CueMix FX is installed with the rest of your V4HD software.

CUEMIX FX BASIC OPERATION

The CueMix FX is simple to operate, once you know these basic concepts.

A separate mix for each output pair

CueMix provides a separate mix bus for every physical audio output pair on the V4HD — a total of 16 stereo buses (or 4 stereo busses at 176.4 or 192 kHz). Each mix can have any number of inputs mixed down to the output pair. For example, you could send your camera's stereo audio output to the V4HD headphones while mixing eight digital inputs to analog outputs 1-2 for monitoring on speakers.

Many inputs to one output pair

It might be useful to think of each mix as some number of inputs all mixed down to a stereo output pair. CueMix FX lets you choose which inputs to include in the mix, and it lets you specify the level and pan for each input being fed into the mix.

Viewing one mix at a time

CueMix FX displays one mix at a time. To select which mix you are viewing, choose the desired mix bus from the *Mix bus* menu (Figure 9-1). Double-click the name to change it.

Each mix is completely independent

Each mix has its own settings. Settings in one mix will not affect another. For example, if an input is used in one mix, it will still be available in other mixes. In addition, inputs can have a different volume, pan, mute and solo setting in each mix.

Widening the CueMix FX window

To view more input faders at once, drag the grow box (Figure 9-1) to the right.

WORKING WITH A MIX

Each mix has the following components:

- A stereo output with master fader
- Name
- Master mute (to enable/disable the entire mix)
- Any number of mono or stereo inputs
- Pan, volume, mute and solo for each input

Viewing a mix

To view a mix, choose it from the *Mix bus* menu (Figure 9-1). The menu shows all mixes by name, followed by the V4HD output pair that it corresponds to.

Naming a mix

Click the mix name to edit its text.

Master fader

The master fader (Figure 9-1) controls the overall level of the mix (its volume on its stereo output). Use the individual input faders to the left to control individual input levels.

Master mute
The master mute button (Figure 9-1) temporarily disables (silences) the mix.

Output level meter
The Output level meter (Figure 9-1) shows you the output for the mix's physical output, which may include audio from your host audio software. The clip indicators clear themselves after a few seconds.

Input section
The channel strips to the left of the master fader represent each input in your V4HD. Use the input scroll bar (Figure 9-1) to view additional inputs.

Mono/stereo pairing
Click the *Mono* button (Figure 9-1) if you would like an input to be treated as a mono channel. If you would like to work with it as one channel of a linked stereo pair, click the *Stereo* button. Inputs are grouped in odd/even pairs (Analog 1-2, 3-4, etc.) Stereo pairs appear as a single channel strip in the CueMix FX mixer.

Naming an input
Click the input name at the top of the input channel strip (Figure 9-1) to edit the name. Input names are global across all mixes. This name also appears in host audio software on the computer (if the software supports channel names).

Input pan
The input pan knob (Figure 9-1) pans the input across the bus stereo outputs. If the input itself is grouped as a stereo pair, two forms of panning control are provided:

Balance
Balance works like the balance knob on some radios: turn it left and the right channel dims, turn it right and left channel dims. But the left channel always stays left and the right channel stays right.

Width
Width spreads the left and right channels across the stereo image, depending on the knob position. Minimum value (turning the pan knob all the way down) maintains the original stereo image: the left channel goes entirely left and right goes entirely right, without attenuation. The maximum value (turning the knob all the way up) inverts the signal, where the left channel goes all the way to the right and vice versa. In between, the left out is a mixture of the left input and some of the right input (and vice-versa) with the effect of narrowing the field. At zero, both the left and right outputs are an equal mixture of left and right.

Input mute/solo
To add an input to a mix, or remove it, click its MUTE button (Figure 9-1). To solo it, use its SOLO button. To toggle these buttons for a stereo pair, hold down the command key while clicking either channel. The Solo indicator LED (Figure 9-1) lights up when any input is soloed (including inputs that may currently be scrolled off-screen).

Input fader
Use the input fader (Figure 9-1) to adjust the level for the input in the mix. Note that an input can have different level, pan, mute and solo settings for different mixes. Input channel level meters are post-fader.

SHORTCUTS
Hold down the following modifier keys as shortcuts:

Shortcut	Result
Shift key	Applies your action to all inputs in the mix.
Shift-Option	Applies your action to all inputs and mixes.
Command key	Applies your action to the stereo input pair.
Option key	Applies your action to all busses.
Double-click	Returns the control to its default value (pan center, unity gain, etc.)

MESSAGE CENTER

The Message Center displays fly-over help for items in the CueMix FX window.

SOLO LIGHT

The Solo light (Figure 9-1) illuminates when any input in the current (active) mix bus is soloed (even if it is currently scrolled off-screen).

TALKBACK AND LISTENBACK

CueMix FX provides *Talkback* and *Listenback* buttons. Talkback allows an engineer in the control room to temporarily dim all audio and talk to musicians in the live room. Conversely, Listenback allows talent to talk to the control room.

Hardware setup

Figure 9-2 below shows a typical hardware setup for Talkback and Listenback. For Talkback, set up a dedicated mic (with a preamp) in your control room and connect it to an input on the V4HD. For Listenback, set up a dedicated listenback mic in the live room for the talent and connect it to another mic input. For talkback output, set up a headphone distribution amp or set of speakers in the live room, and connect it to the V4HD's analog out 7-8, as demonstrated below in Figure 9-2.

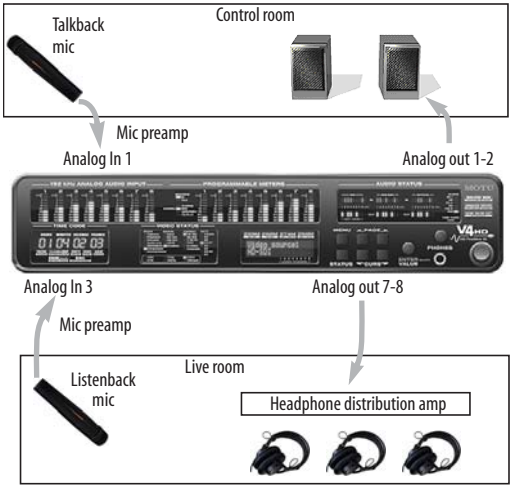


Figure 9-2: Typical hardware setup for Talkback and Listenback.

Talkback / Listenback mic input

Choose the audio input to which your Talkback and/or Listenback mic is connected, as shown below:

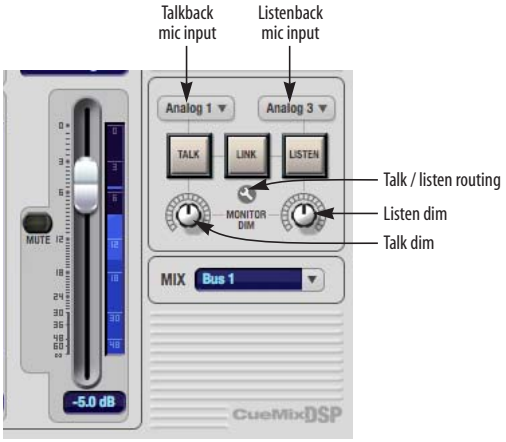


Figure 9-3: Specifying the talkback and listenback mic inputs. Use the input fader for the chosen input to control the mic volume.

Talkback / Listenback monitor dim

Use the *Talk/Listen dim* knobs (Figure 9-3) to set the amount of attenuation you would like to apply to all other audio signals (besides the talkback/listenback volume) when Talkback and/or Listenback is engaged. To completely silence all other CueMix audio, turn them all the way down. Audio playing back from disk (your host software) is not affected.

Talk / Listen signal routing

Click the *Talk/Listen routing* button (Figure 9-3) to open the routing dialog (Figure 9-4). Check the boxes next to the outputs on which you'd like to hear the Talkback mic and/or Listenback mic. For example, as demonstrated in the diagram in Figure 9-2, to hear the Talkback mic on the headphones in the live room, check the *Analog 7-8* check box in the *Talk* column as demonstrated in Figure 9-4. To hear the Listenback mic on the main monitors in the control room, check the *Analog 1-2* check box in the *Listen* column, also demonstrated in Figure 9-4.

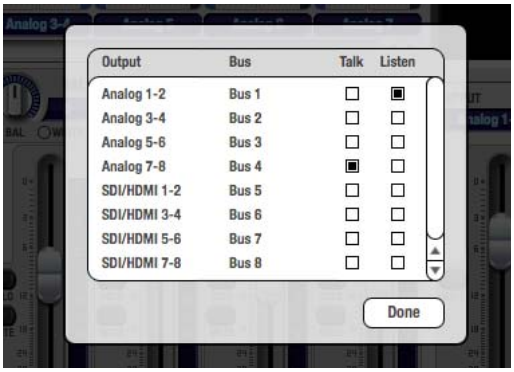


Figure 9-4: Routing the Talkback and Listenback mics to outputs.

Engaging/disengaging Talkback and Listenback

To engage Talkback or Listenback, press on the Talk or Listen buttons (Figure 9-3) and then release to disengage. Talkback and/or Listenback is engaged for as long as you hold down the mouse button. Option-click to make the buttons "sticky" (stay engaged until you click them again — so you don't have to hold down the mouse). Or use the Talkback menu items.

If you would like to engage both Talkback and Listenback at the same time, enable the *Link* button (Figure 9-3).

Controlling Talkback and Listenback volume

To control the volume of the Talkback and/or Listenback mics, adjust their input fader in CueMix FX. This fader controls the volume of the input, regardless of which bus mix is being displayed in the CueMix FX window. In other words, once an input has been designated as a Talkback or Listenback input, its fader becomes global for all CueMix buses.

FILE MENU

Saving and loading hardware presets

The V4HD can store up to four presets in its on-board memory. A preset includes of all CueMix FX settings for all for mix busses, but it excludes global settings like clock source and sample rate.

The *Load Hardware Preset* and *Save Hardware Preset* commands in the CueMix FX File menu let you name, save and load presets in the V4HD.

Peak/hold time

In CueMix FX, a peak indicator is a line (representing a virtual LED) displayed in a level meter that indicates the maximum signal level registered by the meter. The *Peak/hold time* setting (File menu) determines how long this indicator remains visible before it disappears (or begins to drop). To disable peak/hold indicators altogether, choose Off from this sub-menu.

Mix1 Return Includes Computer

The *Mix1 return includes computer output* item in the CueMix FX File menu refers to a feature that is available in other MOTU audio interface products. Therefore, this menu item is grayed out when you are working with the V4HD.

Hardware follows CueMix Stereo Settings

The File menu has a checkable item called *Hardware follows CueMix stereo settings*. When this menu item is unchecked, you can make adjustments to stereo pairing using the front panel LCD on the V4HD itself.

EDIT MENU

Undo/Redo

CueMix FX supports multiple undo/redo. This allows you to step backwards and forwards through your actions in the software.

Copying & pasting (duplicating) entire mixes

To copy and paste the settings from one mix to another:

1 Select the source mix (Figure 9-1) and choose Copy from the Edit menu (or press command-C).

2 Choose the destination mix and choose Paste from the Edit menu (or press command-V).

Clear Peaks

Choose *Clear Peaks* from the Edit menu to clear all peak indicators in all CueMix FX meters.

DEVICES MENU

If you are working with more than one MOTU audio interface product, this menu displays all interfaces that are currently on line. Choose any device from the menu to edit its settings using the CueMix FX software.

CONFIGURATIONS MENU

A configuration is just like a hardware preset (a "snapshot" of all settings in CueMix FX and therefore the V4HD hardware itself), except that it can be created and managed using the CueMix FX software on your computer, completely independently of the V4HD hardware. The commands in the Configurations menu let you create, save, load, import, export and otherwise manage as many configurations as you wish.

Here is a summary of Configurations menu operations:

Configurations Menu item	What it does
Create New	Lets you name and save a new configuration, which appears at the bottom of the Configurations menu.
Save	Overwrites the current configuration (checked in the list at the bottom of the menu) with the current settings in CueMix FX.
Save To	Same as Save above, except that it lets you first choose the configuration you wish to save to (instead of the current one).
Delete	Lets you choose a configuration to permanently remove from the menu.
Import	Loads all configurations from a configuration file on disk.
Export	Saves all current configurations as a file on disk.
Configuration list	Choose any configuration to load it. The current (last loaded or saved) configuration has a check mark next to it.

Modifying a configuration

The name of the current configuration is displayed in the CueMix FX window title bar. If you make any changes to the settings in CueMix FX, an asterisk appears in front of the name to remind you that the current state of CueMix FX doesn't match the saved configuration. If you wish to update the saved configuration with the new changes, use the Save command. To save the current state of CueMix FX to another configuration, use Save To. To save as a new, separate configuration, use Create New.

Saving a CueMix FX configuration as a hardware preset

To save a CueMix FX configuration as a hardware preset:

1 Choose the configuration from the Configurations menu to make it the current active configuration.

2 Choose *File menu> Save Hardware Preset*.

3 Type in a name, choose a preset slot and click OK.

Saving a hardware preset as a CueMix FX configuration

To save a hardware preset as a CueMix FX configuration:

1 Choose *File menu> Load Hardware Preset* to make it the current active preset.

2 Choose *Configuration menu> Create New* (or *Save To*) to save it as a configuration.

TALKBACK MENU

Choose the commands in the Talkback menu to engage or disengage Talkback or Listenback. Use the *Configure Talkback/Listenback* menu item to access the routing dialog shown in Figure 9-4 on page 83.

PHONES MENU

The Phones menu allows you to choose what you will hear on the headphone output, just like the Phones setting in MOTU Audio Setup. However, this menu provides one extra option that is exclusive to CueMix FX: *Follow Active Mix*. This menu item, when checked, causes the headphone output to mirror the output of the current mix being viewed in CueMix FX. For example, if you are currently viewing mix bus 3, the headphones will mirror the mix bus 3 output (whatever it is assigned to).

CONTROL SURFACES MENU

CueMix FX can be controlled from an automated control surface such as the Mackie Control™. Use the commands in the *Control Surfaces* menu to enable and configure this feature.

Application follows control surface

When checked, the *Application follows control surface* menu command makes the CueMix FX window scroll to the channel you are currently adjusting with the control surface, if the channel is not visible when you begin adjusting it. The same is true for the displayed mix: if you adjust a control in a bus that is not currently being displayed, CueMix FX will jump to the appropriate mix to display the control you are adjusting.

Share surfaces with other applications

When the *Share surfaces with other applications* menu command is checked, CueMix FX releases the control surface when you switch to another application. This allows you to control your other software with the control surface. Here's a simple way to understand this mode: the control surface will always control the front-most application. Just bring the desired application to the front (make it the active application), and your control surface will control it. When you'd like to make changes to CueMix FX from the control surface, just bring CueMix FX to the front (make it the active application).

When this menu item is unchecked, your control surface will affect CueMix FX all the time, even when CueMix FX is not the front-most application. In addition, you will not be able to control other host software with the control surface at any time (because CueMix FX retains control over it at all times). This mode is useful when you do not need to use the control surface with any other software.

Mackie Control Surfaces

CueMix FX includes support for the following control surface products:

- Mackie Control™
- Mackie HUI™
- Mackie Baby HUI™

Use the sub-menu commands in the *Mackie Control Surfaces* menu item to turn on and configure control surface support, as described briefly below.

Enabled

Check this menu item to turn on control surface operation of CueMix FX. Uncheck it to turn off control surface support.

Configure…

Choose this menu item to configure your control surface product. Launch the on-line help for specific, detailed instructions for configuring CueMix FX for operation with your control surface product.

Figure 9-5: Refer to the extensive on-line help for details about configuring CueMix FX for operation with your control surface product.

Other HUI-compatible control surfaces

Any control surface that has the ability to emulate a HUI should be compatible with CueMix FX. Just add a Mackie HUI to Audio MIDI Setup and put the control surface hardware into HUI emulation mode. Consult the control surface manual for details about how put it into HUI emulation mode.

Other control surface hardware products

If you install other control surface drivers written for CueMix FX, they will appear as separate menu items at the bottom of the Control Surfaces menu, with the same sub-menu items described above.

CHAPTER 10 MOTU SMPTE Setup

OVERVIEW

MOTU SMPTE Setup gives you access to the V4HD's time code synchronization and generation features when it is operating in Audio only mode, (when the "Enable Video" on page 50 is disabled). When the V4HD's video features are enabled, you manage time code synchronization within the context of Final Cut Pro. See chapter 7, "Final Cut Pro" (page 57).

When operating in Audio only mode ("Audio only" on page 39), the V4HD can resolve directly to SMPTE time code via its LTC input (or any analog input), without a separate synchronizer. The V4HD can also generate time code from its LTC output. The V4HD provides a DSP-driven phase-lock engine with sophisticated filtering that provides fast lockup times and very high accuracy.

MOTU SMPTE SETUP

The included MOTU SMPTE Setup™ software provides a complete set of tools to generate SMPTE for striping, regenerating or slaving other devices to the computer when the V4HD is operating in *Audio Only* mode (see "Enable Video" on page 50).

CLOCK/ADDRESS

The *Clock/Address* menu (Figure 10-1) provides the same global *Clock Source* setting as in MOTU Audio Setup ("Clock Source" on page 73), but it includes additional information: each setting shows both the clock and the address (time code or sample location), separated by a forward slash (/). To resolve the V4HD to SMPTE time code under normal operation, choose the *SMPTE / SMPTE* setting in the Clock/Address menu. This means that the system will use time code as both the time base and the address.

FRAME RATE

This setting should be made to match the SMPTE time code frame rate of the time code that the system will be receiving. The V4HD can auto-detect and switch to the incoming frame rate, except that it cannot distinguish between 30 fps and 29.97 fps time code, or 23.976 fps and 24 fps. So if you are working with either of these rates, make sure you choose the correct rate from this menu.

READER SECTION

The Reader section (on the left-hand side of the window in Figure 10-1) provides settings for synchronizing the V4HD to SMPTE time code.

Status lights

The four status lights (Tach, Clock, Address and Freewheel) give you feedback as follows.

Tach

The Tach light blinks once per second when the V4HD has successfully achieved lockup to SMPTE time code and SMPTE frame locations are being read.

Clock

The Clock light glows continuously when the V4HD has successfully achieved lockup to an external time base, such as SMPTE time code.

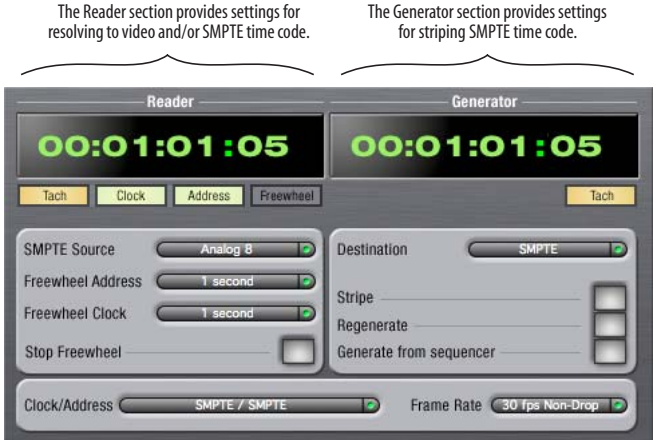


Figure 10-1: SMPTE Setup gives you access to your V4HD's on-board SMPTE time code synchronization features.

Address
The Address light glows continuously when the V4HD has successfully achieved lockup to SMPTE time code.

Freewheel
The Freewheel light illuminates when the V4HD is freewheeling address (time code), clock or both. For details about Freewheeling, see "Freewheel Address" and "Freewheel clock" below.

SMPTE source
Choose *SMPTE*, or the analog input to which the SMPTE time code source is connected. This is the input that the V4HD "listens" to for time code.

Freewheel Address
Freewheeling occurs when there is a glitch or drop-out in the incoming time code for some reason. The V4HD can freewheel past the drop-out and then resume lockup again as soon as it receives readable time code. Choose the amount of time you would like the V4HD to freewheel before it gives up and stops altogether.

The V4HD cannot freewheel address without clock. Therefore, the *Freewheel Address* setting will always be lower than or equal to the *Freewheel Clock* setting, and both menus will update as needed, depending on what you choose.

Keep in mind that freewheeling causes the system to keep going for as long as the duration you choose from this menu, even when you stop time code intentionally. Therefore, if you are starting and stopping time code frequently (such as from the transports of a video deck), shorter freewheel times are better. On the other hand, if you are doing a one-pass transfer from tape that has bad time code, longer freewheel times will help you get past the problems in the time code.

The 'Infinite' freewheel setting
The *Infinite* freewheel setting in the *Freewheel Address* menu causes the V4HD to freewheel indefinitely, until it receives readable time code again. To make it stop, click the *Stop Freewheel* button.

Freewheel clock
Freewheeling occurs when there is a glitch or drop-out in the incoming SMPTE time code for some reason. The V4HD can freewheel past the drop-out and then resume lockup again as soon as it receives a stable, readable clock signal.

The V4HD cannot freewheel address without clock. Therefore, the *Freewheel Address* setting will always be lower than or equal to the *Freewheel Clock* setting, and both menus will update as needed, depending on what you choose.

The 'Infinite' freewheel setting
The *Infinite* freewheel setting in the *Freewheel Clock* menu causes the V4HD to freewheel indefinitely, until it receives readable time code again. To make it stop, click the *Stop Freewheel* button.

Stop Freewheel
The Stop Freewheel button stops the system if it is currently freewheeling.

GENERATOR SECTION
The Generator section (on the right-hand side of the window in Figure 10-1) provides settings for generating SMPTE time code.

Tach light
The Tach light blinks once per second when the V4HD is generating SMPTE time code.

Destination
In the *Destination* menu, choose *SMPTE* from the menu to generate time code from the LTC output on the V4HD rear panel, or choose any other analog output for LTC output.

Stripe

Click this button to start or stop time code. To set the start time, click directly on the SMPTE time code display in the Generator section and type in the desired start time. Or drag vertically on the numbers.

Figure 10-2: Setting the time code start time.

Regenerate

This option, when enabled, causes the generator to generate time code whenever the V4HD is receiving SMPTE time code.

Generate from sequencer

This option, when enabled, causes the generator to generate time code whenever you are running an audio editor such as AudioDesk or Digital Performer. Time code begins at the time specified by the AudioDesk or Digital Performer main transport.

Part 4
Standalone Operation

CHAPTER 11 Standalone Operation

The V4HD can operate as a standalone video and audio distributor and converter. It can also operate as a standalone digital audio mixer.

ENABLING STANDALONE MODE

To put the V4HD in *Standalone* mode, unplug its FireWire cable connection to the computer, or turn off the computer. Standalone mode is very similar to Convert mode: no video goes to FireWire or the computer because it is disconnected, but the currently selected video source is converted, if necessary, and distributed to all other V4HD video outputs.

FRONT PANEL PROGRAMMING

In standalone mode, use the front panel LCD to make settings. See the next chapter "Front Panel LCD Programming" on page 95. Here is a brief summary of the main settings involved.

Choosing a video source

To choose the video source to be converted and sent to all outputs:

1 Press the MENU button repeatedly until you see the VIDEO menu.

2 Press the left/right PAGE buttons until you see the Video Source setting.

3 Turn the VALUE knob to choose the desired video source.

4 Push the VALUE knob to confirm your choice.

Other video settings

After choosing the video source above, press the left/right PAGE buttons to access additional video settings, such as specifying the HD output format.

Sync and time code settings

To access sync and time code settings:

1 Press the MENU button repeatedly until you see the V4HD SETUP menu.

2 Press the left/right PAGE buttons to access the time code settings:

- "Input Timecode" on page 102
- "Output Timecode" on page 102
- "SDI Out TC Format" on page 102

Audio monitoring

To access the audio monitoring features:

1 Press the MENU button repeatedly until you see the CUEMIX menu.

2 Press the left/right PAGE buttons to access the CueMix settings. For complete details, see "CueMix Menu" on page 99.

STANDALONE VIDEO CONVERSION

The V4HD provides hardware-based conversion features, which you can employ during standalone operation. Here are a few examples:

- You could up-convert SD to HD in the V4HD hardware and then distribute it to all HD outputs. Or you could down-convert HD to SD and distribute it to all SD outputs.
- You could connect a 23.976 fps input signal, insert pull-down to 29.97 fps and send this signal to all SD and HD outputs.
- As demonstrated below in Figure 11-1, you could choose SD component (in YPbPr format) as your input source and distribute this input signal to all SD outputs on the V4HD. At the same time, you could also be converting it to 720p or 1080p 23.976 with 14:9 pillar box formatting on all of the V4HD's HD outputs.

These are just a few examples. There are many possible conversion scenarios.

Conversion settings

You can program the V4HD's conversion settings using the front panel LCD. You can also use the Capture/Convert Signal Path settings in the MOTU Video Setup software beforehand, and then disconnect the computer. The Capture/Convert settings you make in the software are remembered and remain in effect during standalone operation.

AUDIO ONLY MODE

To put the V4HD into Audio only mode:

1 Press the MENU button repeatedly until you see the V4HD SETUP menu.

2 Press the left/right PAGE buttons to access the AV Mode setting.

3 Turn the VALUE knob to choose *Audio Only*.

4 Push the VALUE knob to confirm your choice.

This turns the V4HD into standalone 24-channel, 12-bus audio mixer (16 channels and 4 busses at the 4x sample rates). To control the mixer from the front panel LCD, see "CueMix Menu" on page 99.

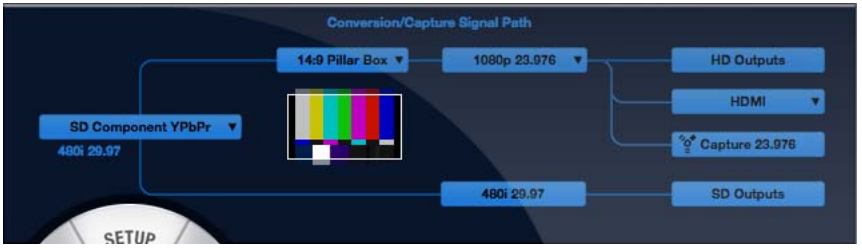


Figure 11-1: An example of standalone hardware distribution and conversion. The V4HD source input is set to SD component YPbPr. The V4HD hardware is distributing this input signal to all outputs and simultaneously converting it to 1080p23.976 with 14:9 pillar box formatting for HD output.

CHAPTER 12 Front Panel LCD Programming

OVERVIEW

The V4HD is the first FireWire video interface to offer complete front-panel programming via a 2x16 backlit LCD display. Almost all V4HD settings can be accessed via these front-panel controls.

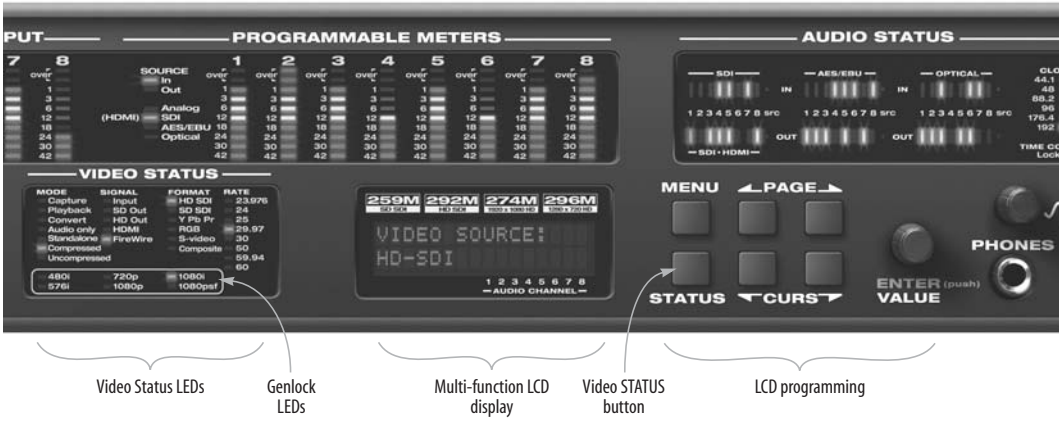


Figure 12-1: The V4HD front panel controls.

VIDEO STATUS

The VIDEO STATUS section (Figure 12-1) provides quick feedback regarding the V4HD's current video operation. It is divided into the following banks of LEDs: MODE, SIGNAL, FORMAT, RATE and Genlock (Figure 12-2):

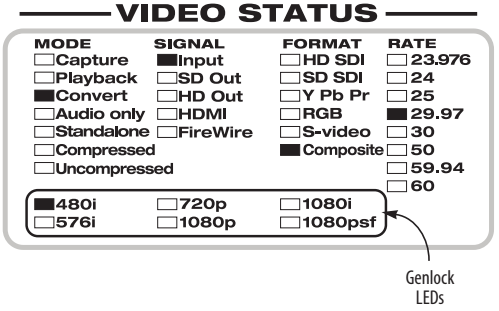


Figure 12-2: The video Status section.

MODE

The MODE bank of LEDs (Figure 12-2) indicates the current operational mode for the V4HD, as summarized below. For complete details on these modes, see chapter 5, "V4HD Basics" (page 37).

MODE LED	What it indicates
Capture	The V4HD is connected to the computer and it is in Capture mode, i.e. it is under the control of Final Cut Pro for log and capture, or it is under control of the MOTU Video Setup software with the Preview tab selected.
Playback	Final Cut Pro is playing back. Or Playback Only mode is enabled. See "Playback Only (disable inputs)" on page 50.
Convert	The V4HD is not in Capture or Playback mode.
Audio only	The Enable Video option is currently disabled and the V4HD is operating as an audio interface only. See "Enable Video" on page 50.
Standalone	The V4HD is not currently connected to a computer via FireWire, or the computer is turned off. See chapter 11, "Standalone Operation" (page 93).
Compressed	Indicates that the currently selected format in the SIGNAL bank is compressed video.
Uncompressed	Indicates that the currently selected format in the SIGNAL bank is uncompressed video (SD only).

SIGNAL

The LEDs in the SIGNAL bank (Figure 12-2) represent the various video inputs and outputs on the V4HD. FireWire is viewed as another input or output, depending on whether the V4HD is capturing or playing back.

The STATUS button

Repeatedly press the video STATUS button (Figure 12-1) to cycle through the input and output signals in the SIGNAL column to view their current settings in the FORMAT, RATE and Genlock banks (Figure 12-2).

All inputs and outputs

As you cycle through the individual formats in the SIGNAL bank, you eventually come to a setting that illuminates all inputs and outputs. This status settings is useful because it tells you, at a glance, everything that is going on with the V4HD inputs and outputs. To learn the status of a specific input or output format, simply keep pressing the STATUS button until its LED illuminates.

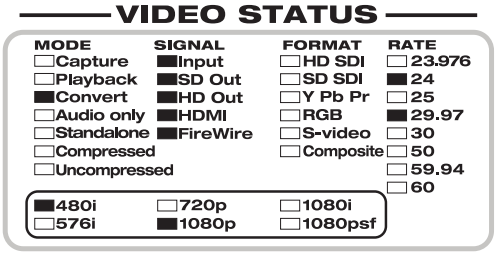


Figure 12-3: Viewing the status of all input and output formats.

FORMAT

The LEDs in the FORMAT bank (Figure 12-2) represent the various video formats supported by the V4HD. When you view the status of an input signal (the Input LED is illuminated in the SIGNAL bank), this bank indicates the currently selected input. The RGB or YPbPr LEDs also indicate the component color space for the currently selected input or output signal.

RATE

The LEDs in the RATE bank (Figure 12-2) indicate the frame rate for the currently selected signal in the SIGNAL bank.

GENLOCK

The LEDs in the Genlock bank (Figure 12-2) indicate the input format to which the V4HD has successfully achieved genlock. It also indicates the format for the currently selected output in the SIGNAL bank. If you are viewing all formats in the SIGNAL bank (Figure 12-3), the Genlock bank will display the SD and HD formats that the V4HD is genlocking to and generating.

Flashing LEDs

When LEDs flash in the VIDEO STATUS section, it means that the V4HD has not yet successfully established genlock. Once genlock is achieved, the LEDs stop flashing.

Blinking LEDs

The *Auto Detect Input Format* menu in the MOTU Video Setup software Setup tab (Figure 6-19 on page 48) lets you choose the degree to which the V4HD will automatically detect the video format for the currently chosen *video source* (Figure 6-3). If you choose the *Manual* option from this menu, you specify the format using the menus in the signal path, as explained in "Manual" on page 48. In this situation, the Genlock LEDs will blink every second or so to indicate that no auto-detection is occurring and than the setting has been specified manually.

MULTI-FUNCTION LCD DISPLAY

The V4HD's *multi-function LCD display* (Figure 12-1) gives you access to the V4HD's many powerful features. You can use the display when the V4HD is connected to the computer and operating as a video (or audio) interface, and you can also use it when the V4HD is not connected to the computer and is instead operating as a stand-alone converter (or audio mixer).

Making settings from the LCD versus the software console

If the V4HD is currently connected to a computer, some settings must be made from the V4HD's console software applications on the computer. In this case, when you try to make a setting in the LCD, you'll see a message that says *Please use computer.*

The MENU, PAGE and CURS (cursor) buttons

Use the MENU, PAGE and CURS (cursor) buttons (Figure 12-1) to navigate the menus in the LCD display, as explained in the following sections.

Push the MENU button repeatedly to access the four main menus:

- V4HD Setup
- Video
- Audio
- CueMix

Use the left/right PAGE buttons to access the various settings in each menu.

Use the left/right CURSOR buttons navigate through multiple settings in the LCD, where available. If there is only a single setting currently displayed, use the VALUE/ENTER knob (below).

The VALUE/ENTER knob

The VALUE/ENTER knob (Figure 12-1) is a push-button digital rotary encoder. Turn it to change the value of the setting currently displayed. The new

value chosen will flash. Push the VALUE knob to confirm your choice; the newly chosen value will stop flashing.

The PHONES knob

The PHONES knob lets you control the volume of either the headphone jack or the outputs on the rear panel that you have designated as the main outs (see "Main Volume Ctl (Control)" on page 102). Press the knob to toggle between the headphones and the main outs. As explained in the next section, the LCD provides detailed feedback as you turn the knob. To view the current setting without changing it, just push the knob (without turning it).

Parameter "zooming"

For many settings, the LCD temporarily "zooms in" to display a long-throw meter and alpha-numeric display to give you precise, real-time feedback as you adjust the setting. For example, if you change the headphone volume, the LCD will display a level meter and gain reduction reading that updates as you turn the volume knob. After a brief time-out, the display returns to its previous state before you turned the volume knob.

Figure 12-4: For many settings, the LCD "zooms in" on the setting as you adjust it.

VIDEO MENU

Press the MENU button repeatedly to access the Video menu. The Video menu gives you access to the many video-related settings in the V4HD, as described briefly below.

Video Source

This is the setting described in "Video Source menu" on page 44.

Auto Detect

This is the setting described in "Auto Detect Input Format" on page 48.

HD Format

This is the setting described in "Format Conversion menu" on page 44.

Up Convert/Down Convert

These are the same settings as described in "SD to HD up conversion formats" on page 45 and "HD to SD down conversion formats" on page 44.

HDMI Source

This is the setting described in "HDMI Output Source" on page 51.

SD Component Out

This is the setting described in "SD Component Output Color Mode" on page 51.

HD Component Out

This is the setting described in "HD Component Output Color Mode" on page 51.

HDMI Mode

This is the setting described in "HDMI/DVI" on page 46.

NTSC Setup

This is the setting described in "480i Setup" on page 50.

480i Component

This is the setting described in "480i Component Analog Format" on page 49.

Legalizer NTSC (or PAL)

This is the setting described in "480i Broadcast Legalizer" on page 51 and "576i Broadcast Legalizer" on page 51.

AUDIO MENU

Press the MENU button repeatedly to access the Audio menu. The Audio menu gives you access to the many audio-related settings in the V4HD, as described briefly below.

Clock Source

This is the setting described in "Clock Source" on page 73.

Sample Rate

This is the setting described in "Sample Rate" on page 73.

Word Clock Out

This is the setting described in "Word Out" on page 77.

Bank Enable

This is the setting described in "Analog Input/Output", "AES/EBU Input/Output", "ADAT Optical Input/Output" and "SDI Input and SDI/HDMI Output" on page 75. Turn the VALUE knob to scroll through each of the four banks, and push the knob to toggle the enable state for each bank (y = yes = enabled; n = no = disabled).

☛ This setting can only be changed in the front panel LCD when the V4HD is in stand-alone mode (not connected to the computer), as explained in "Making settings from the LCD versus the software console" on page 97.

Rate Convert

This is the setting described in "Sample Rate Convert" on page 75.

Meter Mode

This is the setting described in "Programmable Meters" on page 77.

Phones Assign

This is the setting described in "Phones" on page 75.

ADAT Type

The ADAT Type settings is a parameter that can only be made from the V4HD front panel LCD. This setting lets you change the V4HD's 2x optical input and output (88.2 or 96kHz) to *Type I* (for 2x optical connection to SMUX-compatible products) or *Type II* (for 2x optical connection to MOTU products). Turn the VALUE knob to switch between Type I and II, respectively, and then push the knob to confirm your choice.

Additional Delay

This is the setting described in "Additional Audio Delay" on page 76.

Sync Cuemix

This is the setting described in "Sync CueMix audio with video output" on page 77.

CUEMIX MENU

Press the MENU button repeatedly to access the CueMix menu. The CueMix menu gives you access to the V4HD's built-in 32 channel, 16-bus monitor mixer (or 8 channels and 4 busses at the 4x sample rates).

Working with the mixer is much more intuitive using the graphic faders and knobs in the CueMix FX software described in chapter 9, "CueMix FX" (page 79). But this menu lets you control these features in situations where you do not have a computer connected.

For a complete explanation of the V4HD's CueMix monitor mixer, see chapter 9, "CueMix FX" (page 79). Once you have read this chapter, the controls described below will make a lot more sense.

Navigating CueMix parameters in the LCD

The CueMix mixer has the following layout in the LCD display:

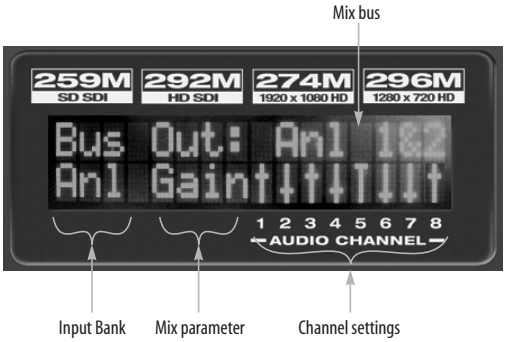


Figure 12-5: Navigating the CueMix mixer in the LCD display.

Use the left/right PAGE buttons to proceed through each CueMix parameter as described in the following sections. When a parameter flashes, use the VALUE knob to access a different bus, parameter, etc. Use the CURSOR buttons to navigate through the eight channel settings (Figure 12-5).

Choosing a bus to work with

CueMix provides a separate mix bus for each of the V4HD's 16 output pairs. Busses are identified by their output pair destination. To access a mix bus, press the left/right PAGE buttons until the Mix bus parameter (Figure 12-5) flashes. Turn the VALUE knob to choose the desired bus.

Input Bank

To access an input bank, press the left/right PAGE buttons until the Input Bank (Figure 12-5) flashes and then turn the VALUE knob to choose the desired input bank. NOTE: only banks that are currently enabled (as shown in Figure 8-1 on page 72) will appear as choices when you turn the knob. In stand-alone mode, you can enable or disable banks using the front panel LCD as explained in "Bank Enable" on page 99.

Mix parameters

Mix parameters are settings such as channel volume (gain), pan, mute/solo, etc. To access the mix parameters for the currently displayed bank, press the left/right PAGE buttons until the Mix parameter (Figure 12-5) flashes and then turn the VALUE knob to choose the desired parameter. You can then modify that setting for each individual input channel, as explained in the next section.

Channel Settings

A *channel setting* is an individual input channel's setting for volume (gain), pan, mute/solo, etc. To access a channel's current setting for the currently displayed mix parameter, press the left/right PAGE buttons until one of the Channel Settings (Figure 12-5) flashes. Use the left/right CURSOR buttons to move among the 8 displayed channels (for the currently chosen Input Bank as shown in Figure 12-5), and then turn the VALUE knob to adjust the value or setting for the parameter. Mix parameters are explained briefly below:

Mix parameter	Range	Comments
Gain	OFF, -84 to 0 dB	Each channel displays a small fader. Push the VALUE knob to toggle between OFF and unity gain (0dB).
Pan	-64 to +64 Zero = pan center	Push the VALUE knob to jump to pan center. Stereo pairs (explained below) are panned hard left/right by default.
Solo	"s" or blank	Push the VALUE knob to toggle between soloed (S) and not soloed (blank), or turn the knob to toggle.
Mute	"m" or blank	Push the VALUE knob to toggle between muted (m) and unmuted (blank), or turn the knob to toggle.
Pair	"[ ]" or blank	This setting applies universally across ALL mixes. Push the VALUE knob to toggle a stereo input pair between separate mono inputs (blank) or a stereo pair ("[ ]"). Or turn the knob to toggle. When a pair of inputs are linked, all of their mix settings become linked (gain, solo, etc.) When the pair is first created, pan is set to hard left and hard right, but the channels can then be further modified independently. When a pair is unlinked, the channels are set to pan-center.

Bus level

The bus level is the overall volume for the bus output pair. To access bus level, press the left/right PAGE buttons until you see *Bus Level* displayed in the top row of the LCD (Figure 12-6). The current bus is displayed in the bottom row. To choose a different bus, press the left/right CURSOR buttons. To adjust the overall output volume for the bus, turn the VALUE knob.

Figure 12-6: Bus level and additional bus settings.

Additional bus settings

You can adjust additional bus settings using the same basic technique as described above for bus level. Additional settings include the following:

Bus Mute

The *Bus Mute* setting lets you temporarily silence the bus output pair.

Init Bus Mix

The *Init Bus Mix* setting lets you reset the current mix. All inputs get reset to unity gain (0 dB), pan center, etc.

Copy Bus Mix

Copy Bus Mix lets you copy all of the settings for the currently displayed mix. Turn the VALUE knob to choose a mix. Push the VALUE knob to copy it. You can then paste the settings to another mix as explained below. The word *Copied* appears briefly to confirm that the mix settings have been successfully copied.

Paste Bus Mix

After you copy mix settings (explained above), *Paste Bus Mix* lets you paste the copied mix settings to another mix. Turn the VALUE knob to choose a mix. Push VALUE to paste. The word *Pasted* appears briefly to confirm the paste. The following mix parameter are included in the paste operation: Gain, Pan, Solo, Mute and stereo pairing. The following mix parameters are not pasted: Bus output, Bus mute and Bus gain.

Save/Name Preset

The *Save/Name Preset* setting lets you name and save up to four separate V4HD presets. A preset holds all of the current CueMix DSP mix settings for all 16 mix busses. Setup parameters are not included. The name can have up to 12 characters. Here is a summary of how to name and save a preset:

To do this:	Do this:
To change the currently flashing character	Turn the VALUE knob
To move to a different character	Press the CURSOR buttons.
To save the preset	Push the VALUE knob. If you are asked to replace existing preset, push VALUE again to replace it, or turn it to select a different preset.

Load preset

After you've saved one or more presets, *Load Preset* lets you recall them. Turn the VALUE knob to choose a preset. Push VALUE to load it. The word *Loaded* appears briefly to confirm the operation.

V4HD SETUP MENU

Press the MENU button repeatedly to access the V4HD Setup menu. This menu gives you access to several important global settings in the V4HD, as described briefly below.

AV Mode

This is the setting described in "Enable Video" on page 50.

LCD Contrast

LCD Contrast lets you adjust the contrast of the front panel LCD display (Figure 12-1).

Input Timecode

This is the setting described in "Timecode Source" on page 49.

Output Timecode

This is the setting described in "Timecode Destination" on page 50.

SDI Out TC Format

This is the setting described in "SDI Output Timecode Format" on page 49.

Main Volume Ctl (Control)

The *Main Volume Control* setting can only be changed from the V4HD front panel LCD. This lets you choose which audio output pairs on the V4HD are controlled using the front panel main volume knob (as explained in "The PHONES knob" on page 98). For example, you could enable analog outs 1-2, which might be connected to a pair of powered speakers. Or you could enable analog outs 1-2, 3-4 and 5-6. This would allow you to have main out volume control for a 5.1 surround mix, using the PHONES knob on the front panel of the V4HD.

The V4HD has 16 output pairs (32 channels total). Turn the VALUE knob to scroll through all 16 output pairs (four in each 8-channel bank). Push the VALUE knob to include it (y = yes = include) or exclude it (n = no = exclude).

Factory Defaults

The *Factory Defaults* setting can only be accessed from the V4HD front panel LCD. The *Factory Defaults* setting restores the V4HD factory settings. Push VALUE to initiate the operation. When the LCD asks "Are you sure?", push VALUE to complete the operation.

Part 5
Appendices

APPENDIX A Troubleshooting

I see the following error message in Final Cut Pro: Unable to locate external device. Why?
If you see the error message below when operating the V4HD with Final Cut Pro, it means that Final Cut Pro has lost communication with the V4HD hardware. Check your V4HD hardware and cable connections.

Figure A-1: If you see this message check your hardware and cable connections.

I am seeing a FireWire bandwidth error message.
If you have connected the V4HD to the computer via the 400 MBit/sec FireWire A port (page 8), you may see a warning message (Figure A-2):

Figure A-2: FireWire bandwidth warning.

If you see this message, try the following:

- In the MOTU Audio Setup console (Figure 8-1 on page 72), choose a lower sample rate (such as 44.1 or 48 kHz).
- In the MOTU Audio Setup console (Figure 8-1 on page 72), disable audio banks you are not using.
- Unplug your FireWire A connection to the computer and switch to a FireWire B connection.

Connecting or powering gear during operation
It is not recommended that you connect/disconnect, or power on/off devices connected to the V4HD while recording or playing back audio. Doing so may cause a brief glitch in the audio.

When I try to genlock via the V4HD's VIDEO REF input, I have problems.
If there is no device connected to the REF THRU jack, make sure that the termination switch is set to the *75Ω TERM* position. Proper termination is critical for successful genlock.

The V4HD is having trouble genlocking to my video deck.
Is the deck connected to a video output from the V4HD? If so, it could be a clock loop problem, where the deck is trying to resolve to its video input, while the V4HD is trying to resolve to video input from the video deck. Try disconnecting the output from the V4HD to the video deck. You could also try choosing the V4HD's manual genlock mode. See "Auto Detect Input Format" on page 48.

I see a message in the MOTU Video Setup preview window that says "Codec Missing". Why can't I see a preview?
If you see a *Codec Missing* message in the Preview frame, this means that MOTU Video Setup cannot find a software component required to display the incoming video format. Compatible codecs are installed with Final Cut Pro. Try installing Final Cut Pro.

My reference monitor(s) connected to the V4HD only displays single frames.
Make sure *All Frames* is selected in the *View>External Video* menu in Final Cut Pro.

My reference monitor(s) connected to the V4HD does not output any video.
Make sure the Final Cut Pro *MOTU RT Enabler* is properly installed in *Library\Application Support\Final Cut Pro System Support\Plugins*.

I'm not seeing any SD output. Why?
SD output is disabled when the HD frame rate is set to 24, 30, or 60 (as opposed to 23.976, 29.97, or 59.94). Check the HD frame rate.

I can't get any video input or output at all. Why?
The V4HD's video features can be temporarily disabled. Perhaps they are currently turned off. See "Enable Video" on page 50.

My HDMI output looks unusually blurry and distorted.
When outputting HD content, go to the Output tab in MOTU Video Setup and click the *HD* button for the *HDMI Output Source* option.

My HDMI output does not output any video.
Make sure the *HDMI/DVI* menu in the signal path diagram is set to HDMI, not DVI.

How can I enable time code when the V4HD is in Audio & Video mode?
Time code becomes active when the *Timecode Destination* option (page 50) gets set to anything other than *None*. Choose HD-SDI or SD-SDI to output the desired time code format from LTC out of the V4HD.

I hear clicks and pops on audio from an external SDI device.
Make sure your Video Source is set to SD- or HD-SDI for V4HD to establish sync.

CUSTOMER SERVICE

We are happy to provide customer service to our registered users. If you haven't already done so, please take a moment to register on line at motu.com/register, or fill out and mail the registration card included with your V4HD. Doing so entitles you to technical support and notices about new products and software updates.

TECHNICAL SUPPORT

If you are unable, with your dealer's help, to solve problems you encounter with the V4HD system, you may contact our technical support department in one of the following ways:

- Tech support hotline: (617) 576-3066 (Monday through Friday, 9 am to 6 pm EST)
- Tech support 24-hour fax line: (617) 354-3068
- Online support: www.motu.com/support

Please provide the following information to help us solve your problem as quickly as possible:

- The serial number of the V4HD system. This is printed on a sticker placed on the bottom of the V4HD rack unit. You must be able to supply this number to receive technical support.
- A brief explanation of the problem, including the exact sequence of actions which cause it, and the contents of any error messages which appear on the screen.
- The pages in the manual which refer to the parts of the V4HD with which you are having trouble.
- Mac OS X version information.

We're not able to solve every problem immediately, but a quick call to us may yield a suggestion for a problem which you might otherwise spend hours trying to track down.

If you have features or ideas you would like to see implemented, we'd like to hear from you. Please write to the V4HD Development Team, MOTU Inc., 1280 Massachusetts Avenue, Cambridge, MA 02138.

APPENDIX B Video Formats

VIDEO INPUT AND OUTPUT FORMATS

The V4HD supports the following video input and output formats:

SD

- 480i29.97 (NTSC)
- 486i29.97
- 576i25 (PAL)

HD

- 720p23.976
- 720p24
- 720p25
- 720p29.97
- 720p30
- 720p50
- 720p 59.94
- 720p60
- 1080p23.976
- 1080p24
- 1080p25
- 1080p29.97
- 1080p30
- 1080PsF23.976
- 1080PsF24
- 1080PsF25
- 1080PsF29.97
- 1080PsF30
- 1080i25
- 1080i29.97
- 1080i30

FINAL CUT PRO VIDEO FORMATS

The V4HD can play back the following video formats from Final Cut Pro:

SD

- Uncompressed 8-bit and 10-bit at 480p23.976, 480i29.97, 486i29.97 and 576i25
- DVCPro25 and DVCPro50 at 480p23.976, 480i29.97 and 576i25

Note: the V4HD supports 480p23.976 SD capture and playback with hardware pull-down insertion/removal.

HD

- Apple ProRes 422 in standard or HQ modes. Or any similar full-raster video format supported by Final Cut Pro with a 10-bit 4:2:2 color space and a compression ratio similar to ProRes (approximately 6:1 or higher).
- DVCProHD 720p at 720p23.976, 720p24, 720p25, 720p29.97, 720p30, 720p50, 720p 59.94, 720p60
- DVCPro HD 1080i50 (1440 x 1080) and 1080i60 (1280 x 1080) at all 1080i frame rates listed on this page

The V4HD can capture and play back DVCProHD 1080i50 at 30 fps, which provides better resolution (1440 pixels wide) than 1080i60 (1280 pixels wide). However, the 1080i50 format is not widely supported and cannot be recorded or played by other DVCPro HD compatible devices, such as a DVCPro HD video deck or camera.

APPENDIX C V4HD Specifications

VIDEO I/O

- 1 x HD-SDI in and out (4:2:2 10-bit) on independent BNC connectors
- 1 x SD-SDI in and out (4:2:2 10-bit) on independent BNC connectors
- 1 x extra HD-SDI output connector
- 1 x extra SD-SDI output connector
- 1 x HDMI output (4:2:2 10-bit, YCbCr or RGB)
- Support for DVI output with HDMI-to-DVI adapter (sold separately)
- 1 x HD component in and out (10-bit, YPbPr or RGB) on independent BNCs
- 1 x SD component in and out (10-bit, YPbPr or RGB) on independent BNCs
- 1 x composite in and out (10-bit)
- 1 x S-video in and out (10-bit)
- 12-bit A/D and D/A converters on all analog video in/out with up to 8x oversampling
- 1 x 400 Mbit (1394) FireWire A
- 2 x 800 Mbit (1394b) FireWire B

AUDIO I/O

- 32 channels of simultaneous audio input and output
- 8 channels of analog in/out at all standard sample rates from 44.1 to 192kHz
- 4 x XLR analog in/out — provides 4-channel direct connection without a breakout cable
- 8 channels of AES/EBU digital in/out at sample rates up to 96kHz
- 2 x AES/EBU connectors — provides 4-channel direct connection without a breakout cable
- 8-channel HD-SDI and SD-SDI embedded audio in/out, 24-bit at 44.1 or 48kHz
- 8-channel HDMI embedded audio output, 24-bit at 44.1 or 48kHz
- 8-channel ADAT optical digital audio in/out — includes a second bank of optical connectors for 8-channel operation at sample rates up to 96kHz.
- Flexible 8-channel sample rate conversion — apply rate conversion to any 8-channel digital input or output bank, including AES/EBU, embedded and optical.
- Front panel headphone jack with dedicated volume control
- Programmable front panel volume control for up to 32 audio outputs — push the headphone volume knob and then turn it to control output level for any/all outputs, from stereo main outs to 7.1 surround to all 32 outs. The LCD provides visual feedback for the digital rotary encoder as the user turns it.
- CueMix FX built-in monitor mixer — 32-channel, 16-bus mixer for monitoring live inputs from cameras, mic preamps or other audio sources with no delay. Set up send/return loops to digital mixers and outboard audio processing.
- Multiple CueMix FX mixes — create up to 16 separate stereo monitor mixes (four stereo at 176.4 or 192kHz) for main outs, headphones, outboard gear send/return loops, etc.

■ Audio delay compensation — both fully automated and programmable controls ensure that audio always remains perfectly in sync with picture.

■ Audio only mode — operates as a 24 channel cross-platform audio interface.

■ Stand-alone operation — mix and monitor audio with no computer connected.

SYNC AND DEVICE CONTROL

■ Video reference in and thru — resolves to blackburst, composite or HD Tri-level sync.

■ Time code in and out — generates and resolves to time code (LTC, SD VITC or embedded).

■ RS-422 machine control — control the transport of a connected camera or video deck using Final Cut Pro or other machine control host via standard 9-pin protocol.

■ Word clock in, out and thru — continuously resolves to audio word clock from a digital mixer, distribution box or other source at sample rates from 44.1 to 192 kHz.

■ Direct Digital Synthesis — DSP-driven phase lock engine provides ultra-low audio jitter.

■ Field upgradable firmware via USB — allows you to download new functionality from a computer.

■ International auto-switching internal power supply

FRONT PANEL PROGRAMMING AND MONITORING

■ Front-panel backlit LCD — provides access to most settings directly from the front panel.

■ 8 dedicated 10-segment ladder LEDs with clip indicators for all 8 analog audio ins

■ 8 programmable 10-segment ladder LEDs with clip indicators for displaying any 8-channel bank (analog, AES/EBU, optical or embedded) in or out

■ Video status LEDs — provide quick access to capture/playback settings for each video format.

■ Time code display — provides frame-accurate time code readout when converting or generating time code, or during playback from host software.

INCLUDED SOFTWARE AND COMPATIBILITY

■ Includes MOTU Video Setup software — graphically displays HD and SD signal path and provides complete control of all programmable features and settings.

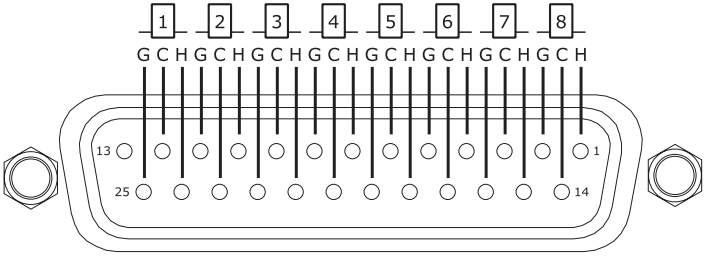
■ Includes CueMix FX software — provides on-screen mixing of all 32 audio channels of analog and digital input and output via graphic mixer with 32 faders.

■ Supports Final Cut Pro 5.1 or later

APPENDIX D DB25 to XLR Pin Outs

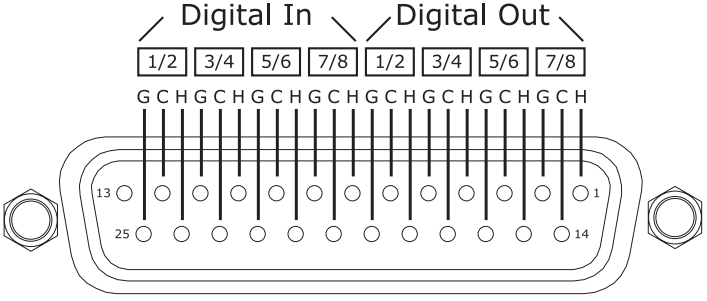
DB25 TO 8 FEMALE (IN) OR MALE (OUT) XLR
For balanced V4HD analog input or output
Panasonic/Tascam standard

ANALOG DB25
8 CHANNEL BALANCED IN OR OUT



DB25 TO 4 FEMALE (IN) / 4 MALE (OUT) XLR
For bi-directional V4HD AES/EBU digital I/O
Panasonic/Tascam standard

AES/EBU DB25
8 CHANNEL BIDIRECTIONAL IN AND OUT



DB25 TO 8 FEMALE (IN) OR MALE (OUT) XLR

For balanced V4HD analog input or output
Panasonic/Tascam standard

Pin	Signal
1	Channel 8 (+)
2	SG (Signal Ground)
3	Channel 7 (-)
4	Channel 6 (+)
5	SG
6	Channel 5 (-)
7	Channel 4 (+)
8	SG
9	Channel 3 (-)
10	Channel 2 (+)
11	SG
12	Channel 1 (-)
13	Not used
14	Channel 8 (-)
15	Channel (7 (+)
16	SG
17	Channel 6 (-)
18	Channel 5 (+)
19	SG
20	Channel 4 (-)
21	Channel 3 (+)
22	SG
23	Channel 2 (-)
24	Channel 1 (+)
25	SG

DB25 TO 4 FEMALE (IN) / 4 MALE (OUT) XLR

For bi-directional V4HD AES/EBU digital I/O
Panasonic/Tascam standard

Pin	Signal
1	Channel 7/8 Out (+)
2	SG (Signal Ground)
3	Channel 5/6 Out (-)
4	Channel 3/4 Out (+)
5	SG
6	Channel 1/2 Out (-)
7	Channel 7/8 In (+)
8	SG
9	Channel 5/6 In (-)
10	Channel 3/4 In (+)
11	SG
12	Channel 1/2 In (-)
13	Not used
14	Channel 7/8 Out (-)
15	Channel 5/6 Out (+)
16	SG
17	Channel 3/4 Out (-)
18	Channel 1/2 Out (+)
19	SG
20	Channel 7/8 In (-)
21	Channel 5/6 In (+)
22	SG
23	Channel 3/4 In (-)
24	Channel 1/2 In (+)
25	SG

A

B

C

D

E

F

G

H

Q

R

S

T

U

V

W

X

Y