
# Universal Slave Driver™ User's Guide

Version 3.0

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PN 932004489 Rev. A – May 1997

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- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

If necessary, consult an experienced radio/television technician for additional suggestions. The following booklet prepared by the Federal Communications Commission may also be helpful: "How to Identify and Resolve Radio-TV Interference Problems." The booklet is available from the U.S. Government Printing Office, Washington, DC 20402 Stock No. 004-000-00345-4

### Communications Statement

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- The equipment should only be connected to the correct rating power supply as indicated on the product.
- Do not attempt to service the equipment. There are no user-serviceable parts inside. Please refer all servicing to authorized Digidesign personnel.
- Any attempt to service the equipment will expose you to a risk of electric shock, and will void the manufacturer's warranty.
- The product should be connected only to the correct power supply as indicated on the product.

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# Welcome to the Universal Slave Driver

# Welcome to the Universal Slave Driver

1

## Introduction

Thank you for purchasing the Digidesign Universal Slave Driver! The Universal Slave Driver is a sophisticated, high-quality, multipurpose synchronization device. It has many applications, and supports all the major time code and clock reference standards used by the audio, video, film, and multimedia communities.

The Universal Slave Driver is designed primarily for use with Digidesign digital audio workstations, especially Digidesign AudioVision and Pro Tools. Certain audio, video, film, and multimedia professionals will also find the Universal Slave Driver very useful for some of its stand-alone synchronization conversion, time code generation, and clock generation capabilities.

### How Does the Universal Slave Driver Compare to the SMPTE Slave Driver™ and the Video Slave Driver™?

Many audio post-production facilities use Digidesign's SMPTE Slave Driver to lock Digidesign audio systems to an external LTC (linear time code) source, and to resolve to a Slave Clock reference derived from the incoming LTC. This way, the SMPTE Slave Driver provides the *positional reference* for the external time code source (in hours:minutes:seconds:frames) and the *clock reference* (i.e. how long each frame lasts). In other words, the SMPTE Slave Driver tells Digidesign audio systems *where* it should be and, with high degree of accuracy, how *long* each frame should last.

These audio post-production facilities may also use Digidesign's Video Slave Driver to resolve to a Super Clock reference derived from an external video or house sync (black burst) signal. The Video Slave Driver provides the *clock reference* for Digidesign audio systems to run at the same speed as other devices resolving to the same master clock source.

The Universal Slave Driver integrates the functions of both the SMPTE Slave Driver and the Video Slave Driver, plus it adds many other functions. For many users, the most significant additions will be the ability to read and write VITC, plus the ability to insert a *Window Burn* onto a video signal. These and other features are described in detail in this manual.

## Features Overview

The Universal Slave Driver allows Pro Tools, AudioVision and other devices to synchronize playback and record with a variety of time code and clock reference sources.

These reference sources include:

- Video reference sync (black burst);
- Digidesign Super Clock (also termed "Slave Clock"; 256x sample clock);
- Vertical-interval time code (VITC);
- Composite video;
- Word clock (1x sample clock);
- Linear time code (LTC; formerly known as longitudinal time code);
- AES/EBU null clock (AES "black," at 44.1 and 48kHz sample rates);

- Bi-phase/Tach (various rates);
- Pilot tone (50/60Hz); and
- Universal Slave Driver's own internal crystal reference (with variable speed capability).

The Universal Slave Driver can also be used to output both time code and clock reference signals. While resolved to one of the above reference sources, the Universal Slave Driver can simultaneously read time code (or bi-phase) and generate:

- Digidesign Super Clock (256x sample clock);
- Word Clock (1x sample clock);
- AES/EBU null clock (AES "digital black");
- VITC (if a video input is present);
- LTC; and
- MIDI Time Code (MTC).

Other features include:

- USD Setup software (included). This Macintosh program gives you easy, remote control over all the Universal Slave Driver's functions.
- Front panel controls and a large, bright time code display window—allowing you to use the Universal Slave Driver as a stand-alone reader/generator/converter, with direct access to almost all features.
- Window dubbing capabilities, for overlaying or "burning" a time code display window onto a video signal, including VITC generation.

In addition, the Universal Slave Driver offers extremely fast lockup; near-sample accurate synchronization; and an exceptionally low-jitter clock. These features provide you with professional performance and maximum audio fidelity, under a wide range of synchronization conditions.

## Applications Overview

With its many features, the Universal Slave Driver has a wide variety of applications for audio, video, film, and multimedia. The Universal Slave Driver can be used as:

- LTC reader and generator;
- VITC reader and generator (with window burn capabilities);
- Stand-alone time code and clock format converter;
- Time code regenerator, for replacing damaged time code;
- Master clock for a Digidesign audio workstation-equipped studio; and
- Fast and accurate universal synchronizer for Digidesign AudioVision or Pro Tools, allowing it to slave to, or be master to, many different types of external devices.

## System Requirements

All of the Universal Slave Driver's functions can be controlled remotely from a computer using the USD Setup software (included). You'll probably find that using USD Setup is even easier than using the Universal Slave Driver's front-panel controls.

USD Setup has the following system requirements:

- A Digidesign-qualified, PowerPC-equipped Macintosh computer with an available serial port.
- Apple's System software version 7.5.3 or higher running in 32-bit mode.
- A 14-inch or larger color monitor; a 17-inch monitor is recommended.

### Compatibility Information

The Universal Slave Driver generates industry-standard clock and time code signals, including MIDI Time Code. Devices that are compatible with these clock and positional reference formats can be used with with the Universal Slave Driver.

Some professionals with specialized needs may be using the Universal Slave Driver in a "stand-alone" mode. For instance, the Universal Slave Driver can serve as a time code generator, with its own internal clock serving as the clock reference. Similarly, it can reference any compatible clock source, while in turn generate time code. These are just two of the Universal Slave Driver's several stand-alone applications, which have no specific hardware or software requirements (beyond industry-standard reference sources and the appropriate cabling connections).

However, most users will be integrating the Universal Slave Driver into a Digidesign workstation-equipped studio. If this applies to you, please ensure that your Digidesign system complies with the following requirements.

#### Digidesign System Compatibility

The Universal Slave Driver has been tested to be fully compatible with the following Digidesign workstations and accessory products:

- All TDM-equipped Pro Tools systems (NuBus and PCI);
- SampleCell II (with or without TDM); and
- Digidesign Expansion Chassis;

In addition, the Universal Slave Driver is compatible with several popular third-party hardware products, including:

- Opcode's professional MIDI Interfaces, including the Studio 3, Studio 4, and Studio 5;
- Mark of the Unicorn's professional MIDI Interfaces, including the MIDI Time Piece, MIDI Time Piece II, and MIDI Time Piece AV;
- TimeLine's Lynx I, Lynx II, and MicroLynx synchronizers (for machine control applications);
- VideoMedia's V-LAN interfaces (for machine control applications; requires Digidesign's optional MachineControl™ software for Pro Tools); and
- Lexicon's NuVerb digital effects card.

## About This User's Guide

This User's Guide contains all the information you'll need in order to install and use your Universal Slave Driver. This section will give you an overview of how your User's Guide is organized.

**Chapter 1: Introduction** lists the Universal Slave Driver's system requirements, package contents, and features. It also provides some background information on the Universal Slave Driver and its capabilities in the world of post-production, and reviews some fundamental concepts regarding positional and clock references.

**Chapter 2: Integrating the Universal Slave Driver Into Your Studio** gives step-by-step instructions for integrating the Universal Slave Driver with your studio, as well as suggestions for making all the necessary MIDI and audio connections. This chapter also shows you how to install the USD Setup software.

**Chapter 3: Operating the Universal Slave Driver Using USD Setup Software (Remote Control)** shows you how to use the USD Setup software to control the Universal Slave Driver remotely from your Macintosh.

**Chapter 4: Operating the Universal Slave Driver Using the Front Panel (Local Control)** shows you how to control the Universal Slave Driver locally from the front panel controls.

**Chapter 5: Troubleshooting** provides suggestions for troubleshooting synchronization problems.

**Chapter 6: Glossary** defines terms used in this User's Guide.

**Appendix I: Technical Specifications & Connector Pin-outs** provides technical specifications for the Universal Slave Driver and connectors used on its back panel.

**Appendix II: Calibrating the USD Oscillator** provides instructions on calibrating the frequency of the on-board crystal oscillator.

**Appendix III: Bibliography** lists sources and additional readings for some of the concepts and procedures covered in this User's Guide.

The **Index** is an alphabetical index of this User's Guide.

### Conventions Used in this Manual

The following two examples show how this manual uses special graphics and type styles to draw your attention to important information.

1. Whenever the User's Guide has a word of caution relating to an upcoming task, this exclamation mark icon appears:

*The exclamation mark icon will be followed by text (always italicized) explaining the situation and its options.*

2. Whenever the User's Guide has a tip or hint for you, it will be designated as such by this check mark icon:

*User Tip: The check mark icon will be followed by text (always italicized) explaining the situation and its options.*

## About Your Universal Slave Driver Package

Your Universal Slave Driver package consists of three basic elements:

**Hardware:**

- Universal Slave Driver synchronization device;
- Power cord (U.S. standard);
- Four meter-long (12') serial cable for connecting your Universal Slave Driver with your Mac;
- 75Ω BNC video terminator; and
- Four rubber feet.

*Note: This cable is a specialized "hardware-handshaking" serial cable, as is used with many modems. Most ordinary Mac serial cables are either incompatible or may be unreliable. If you require a longer cable, or a replacement cable, please contact Digidesign Customer Support for recommended solutions.*

**Software:**

- The USD Setup Installer Disk. The *Install USD Setup* application on this disk allows you to install required software for remote control of the Universal Slave Driver from your Mac. The Installer Disk also includes the current operating firmware version which is downloadable to the Universal Slave Driver via a serial connection, and the USD Setup Read Me file which contains late-breaking information regarding the Universal Slave Driver and this User's Guide.

**Documentation and Information:**

- This Universal Slave Driver User's Guide, containing all installation and operational instructions for the Universal Slave Driver.

**Recycling Your Universal Slave Driver Packaging**

Most of the materials used in your Universal Slave Driver package can be recycled. Please consult your local recycling center to make sure you dispose of these materials in the best way possible. Here is some information and general recommendations about the materials used in your Universal Slave Driver package:

- The inside corrugated cardboard liner can be recycled. (It replaces the more common, and much less biodegradable, foam liner.)
- Instead of a plastic diskette envelope, your USD Setup Installer disk is shipped in a paper envelope. Again, you should recycle it.
- In some localities, it might be difficult to recycle the outer cardboard box (because it has a four-color wrap). If it is difficult to find a recycler that can recycle the box, the box makes an ideal storage container for cassette tapes.
- We encourage you to recycle the Universal Slave Driver User's Guide some day when you are through with it (i.e. when you have memorized every single word!).

We're doing what we can to protect our environment. Please help us out by recycling the materials in your Universal Slave Driver package when you're through with them.



## Before You Begin

It's our hope that, with the help of this manual, using your Universal Slave Driver will be a straightforward and productive process. As you'll find within these pages, we've attempted to describe many aspects of time code and synchronization, particularly as they apply to Pro Tools and the Universal Slave Driver.

However, it's important to realize that time code and synchronization are particularly complex topics, which have filled more than one textbook. Consequently, this manual has been written with the assumption that you already understand several key technologies:

1) You should be familiar with time code and the basic concepts of synchronization. If you run into any questions regarding time code that are not covered in this manual, we suggest you refer to the bibliography in Appendix III.

2) You should have a working understanding of any third-party products that may connect to the Universal Slave Driver. For instance, if you're using a device that may send or receive time code (such as a video tape recorder), you'll need to understand how that device generates or receives time code. We suggest you refer to your respective manuals when necessary.

3) We strongly recommend that you research what your time code requirements are before you begin using the Universal Slave Driver. For instance, if you're using Pro Tools to accomplish audio post-production work for video, consult with your video engineer or editor as to exactly what format time code he or she is using. There may be other time code-related issues or expectations, any of which may affect how you use your Universal Slave Driver. Your Digidesign dealer may also be able to offer helpful suggestions to help you integrate the Universal Slave Driver into your studio.

We've written this manual with two other assumptions in mind. One—which applies to all references regarding the USD Setup software—is that you have a working knowledge of standard Macintosh users' techniques, including how to:

- Set up, start, and use your Macintosh;
- Use the Finder and desktop icons to open, copy, and delete Macintosh files, applications, and disks;
- Double-click, select, Shift-select, Shift-click, and drag with your mouse or trackball;
- Open, close scroll, move, re-size, and select Macintosh windows; and
- Choose commands from the various menus.

If you're unfamiliar with these tasks, and plan to be using the USD Setup software, you should spend some time learning your Macintosh before going any further.

One final assumption—which applies if you are using the Universal Slave Driver with an audio workstation such as Pro Tools or AudioVision—is that you have a working knowledge of that product. If not, you should first become familiar with its basic operations and features.

## Why Synchronization is Necessary

Synchronization is necessary for two reasons. First, it allows connected systems to start and stop their transports together, without requiring an operator to run all the transports individually. Secondly, it keeps the systems in lock-step while their transports are running, so that no individual system gets ahead of, or behind any other system.

Without synchronization, even if the operator were able to start and stop each individual transport manually at precisely the same time, once the transports began running, they would all run at slightly different rates over time. Analog tape transports or flatbed film editors, being mechanical, take variable amounts of time to ramp up to full playback speed and have small fluctuations in tape speed called "wow" and "flutter." And even servo-controlled capstans on tape machines can slip over time as well, generating changes in tape speed.

With disk-based systems such as Pro Tools and AudioVision, playback and record speeds are controlled by quartz crystal oscillators. However, no two oscillators are exactly the same, and an oscillator's frequency can vary with time and temperature. What all this means is that when any two systems, analog or digital, are started at exactly the same time, they will begin to drift apart over time, and the audio on the different systems will eventually drift out of sync.

Synchronization is achieved in these systems by constantly checking to see the master device's current SMPTE frame, and adjusting the playback speed to keep all devices locked. In analog systems, this is achieved by varying motor speed control. In digital systems, it is achieved by adjusting the playback sample rate clock. The process of forcing a slave device to change its playback speed or sample clock rate (in the case of a digital audio system) in order to follow a master is called *resolving*.

## Using SMPTE Time Code

The basic idea behind a SMPTE-synchronized network of devices is that each device (analog tape machine, video tape machine, etc.) is initially "striped" with SMPTE time code before anything else is recorded. One of the devices is assigned to be the "master," and all other devices read and follow the SMPTE time code from the master. They follow (or synchronize to) the master device by comparing their own SMPTE time code "stripes" to the incoming code from the master device, and continually adjust their own transport speed so that all devices are registering the exact same SMPTE time code value at the same time.

In such a system, if the master device begins to slow down, all other devices will slow down right along with it, matching the master's speed variations so that all devices are playing back at the same speed. Even after long periods of time they will still be exactly locked to each other because the current master SMPTE time is mirrored by all slave devices.

### Striping Tape With SMPTE

To set up such a system, you must first "stripe" each medium (video tape, audio tape, and so on) with SMPTE time code. On analog tape machines, this means recording longitudinal SMPTE time code (LTC) on one of the tracks of the audio tape. On video tape machines, you can record LTC on one of the audio tracks or control track of the video tape—or you can record Vertical Interval SMPTE time code (VITC) in the vertical blanking interval of the video signal itself.

If you expect to send any of your SMPTE-striped material to someone else, or especially if you intend to provide it for professional broadcasting purposes, you must try to be sure that the SMPTE time code that your generator is producing is very accurate. This is accomplished by resolving (or synchronizing) the actual SMPTE time code generator itself to a very accurate clock signal, such as video "house sync" or "black burst." This is the only way to guarantee that the SMPTE time code on tape is within the tight timing tolerances that professional broadcasting requires.

If you do not resolve your generator, or if your generator is incapable of being resolved (most low-cost SMPTE generators cannot be resolved), then you cannot ensure that a professional broadcaster will obtain accurate results from the tapes you produce. If you only use SMPTE within your own work environment, and if you do not use it in context with video, then an unresolved generator provides less of a problem. However, the most flexible choice is to buy the best resolvable generator (and black burst source, if needed) that you can afford, since this generator provides the heartbeat of your entire SMPTE system.

Because Pro Tools and AudioVision are completely digital systems, you do not need to stripe any track with SMPTE if you are using these systems in "stand-alone" applications. Pro Tool and AudioVision use their digital sample clocks as a reference to generate and read time code very accurately. You only need to specify the SMPTE time at which you want a region to start, and Pro Tools or AudioVision can translate SMPTE times to digital sample numbers "on the fly."

Any slave devices in the system other than Pro Tools and AudioVision may require their own transport synchronizer in order to follow the master SMPTE time code. The master device itself does not need a synchronizer, since it is generating rather than reading. Your Pro Tools or AudioVision system can be used as master or slave, since it can either read or generate time code with the addition of the Digidesign Universal Slave Driver.

Pro Tools and AudioVision can synchronize to SMPTE time code by getting positional information from the Universal Slave Driver. The Universal Slave Driver takes the SMPTE signal and convert it into a MIDI-based version of SMPTE (known as MIDI Time Code or MTC) that is fed into your computer's serial port (modem or printer).

*The SMPTE time code formats striped on all devices must match. Different devices must not have different frame rates. Mismatched frame rates will result in major sync problems, since they will start playback at different points.*

## Fundamental Concepts for the Universal Slave Driver

As we've described, the Universal Slave Driver can synchronize two or more devices, using a variety of different positional and clock references. Understanding the nature of these references is the key to understanding the nature of the Universal Slave Driver.

Positional and clock references are related to one another—in that both are necessary to perform most types of synchronization—but they are different from one another. For instance, let's consider a sync situation, where you wish to synchronize a Pro Tools or AudioVision system to a video tape recorder (VTR). In this situation, in order to maintain sync, your Universal Slave Driver needs to "know" the answers to two questions:

- "Where are we?" (positional reference); and
- "How fast are we going?" (provided by the clock reference)

In other words, in order for the Universal Slave Driver to sync Pro Tools or AudioVision to the VTR, it needs to know where the videotape is (in terms of time) and at what speed it's running. Using the answers to both these questions, the Universal Slave Driver can establish synchronization between Pro Tools or AudioVision and the VTR. Furthermore, with answers to these same two questions, the Universal Slave Driver can synchronize a wide variety of devices. Let's take a closer look.

The following sections are intended as a brief introduction to the Universal Slave Driver's capabilities. Each of these will be addressed in greater depth in the coming chapters.

## About Positional References (Time Code & Bi-phase)

As you might guess, the "Where are we?" question refers to relative position. To describe position, many professional audio, video, and multimedia devices and programs use *SMPTE time code* (named for the standards committees of the Society of Motion Picture & Television Engineers).

*Note: Certain MIDI devices respond to MIDI Time Code, which is another type of time code that the Universal Slave Driver can generate. However, unless otherwise specified, when we refer to "time code," we're referring to SMPTE time code.*

Time code is timing information in the form of a data stream that can be recorded on magnetic tape as an audio or video signal. Time code can be used to synchronize the playback and recording of your Pro Tools or AudioVision system with another audio system, such as an analog multitrack tape machine or a video tape recorder (VTR), and it is the most typical way by which the Universal Slave Driver obtains positional reference.

Time code is based on hours, minutes, seconds, and frames. Depending on the SMPTE frame format (covered in the next section), one frame is equal to 1/24th, 1/25th, 1/29.97th, or 1/30th of a second. The frame is used as a unit of time measurement due to time code's origin in film and video applications. For instance, a videotape time code reading of "01:12:27:15" would tell us that we were at a position of one hour, twelve minutes, twenty-seven seconds, and fifteen frames.

Because SMPTE stores an absolute time reference on the tape in the form of time code, any location on that tape can be precisely located by devices that read time code. Once the time code has been recorded or "striped" on a tape, it provides a permanent time reference that allows Pro Tools or AudioVision to link the playback of an event to an exact tape location. Thanks to time code synchronization, a gunshot sound effect can be played at the precise instant that the gun's flash appears on-screen, and so on.

There are two basic techniques used to record time code onto magnetic tape: LTC (Linear Time Code) and (VITC) Vertical Interval Time Code. LTC is recorded on an audio channel or a dedicated time code track of the audio or video device. VITC is recorded within the video signal in the video "blanking area" of each video frame. VITC cannot be recorded on audio tracks, so it has no application when working with audio tape recorders, but it does offer powerful features for post production professionals that work with video.

The Universal Slave Driver can obtain positional information from either of the two types of external time code:

- **LTC (Linear Time Code)** — a type of time code that's recorded and played back time in the form of an analog audio signal; supported by many audio and video tape recorders. LTC can be read at high tape shuttle speeds, allowing a machine's time code reader to communicate with synchronizers at rewind or fast forward speeds exceeding 50 times playback speed (provided the tape recorder is able to reproduce the time code at this speed). Unfortunately, LTC cannot be read at very slow shuttle speeds (such as when you are "crawling" the tape frame by frame) or in pause. Sound effects editors often shuttle the video tape frame by frame to locate the exact point at which the sound effect should occur. With LTC, the VTR must be running (usually at a minimum speed of about 1/10th normal playback speed) in order to capture a SMPTE time address.
- **VITC (Vertical Interval Time Code)** — a more sophisticated type of time code that's recorded and played (or "embedded") as an invisible part of a video signal; commonly used in professional video editing and audio-for picture applications. Because VITC is recorded as part of each video frame, it must be recorded at the same time as the video signal—it cannot be added later as LTC can. Since VITC cannot be recorded on audio tracks, it's never used to synchronize audio-only recorders. As a result, LTC is more commonly used in audio-only applications. VITC's ability to capture a time code value when moving a VTR transport at slow speeds or paused makes it much more useful in audio post-production environments.

*User Tip: When VITC is used, Pro Tools or AudioVision can capture the current SMPTE time from the VTR when it's paused or in "crawl" mode. However, if you are using additional external tranposrt synchronizers in your setup, most synchronizers cannot read VITC at speeds exceeding about 10 times playback speed, preventing slaved machines from maintaining synchronization during rewind and fast forward.*

In addition to external time code, the Universal Slave Driver can obtain positional information from another external source:

- **Bi-phase/Tach** — an electronic pulse train used commonly by film mag recorders, film editing stations, and film projectors. Unlike time code, bi-phase/tach doesn't actually contain specific location information; rather, it simply supplies speed (based upon the frequency of the pulses) and direction. However, since the Universal Slave Driver can "count" both the speed and direction of the stream of pulses, it can use a bi-phase/tach source to deduce positional information from a starting "address point." The difference between bi-phase and tach formats is bi-phase encodes rate and direction on a pair of signals using a format called *phase-quadrature*, while tach encodes rate on one signal and direction on the other.

Finally, it's possible for the Universal Slave Driver to create its own positional information, to act as your studio's positional "master" reference. It does this by using its:

- **Internal Time Code Generator** — a crystal-locked, highly accurate time code source generated internally by the USD.

## SMPTE Time Code Formats

Six different formats of SMPTE time code exist, and the Universal Slave Driver supports all of them: 30 frames per second (fps), 30 fps Drop frame, 29.97 fps, 29.97 fps Drop frame, 25 fps (EBU) and 24 fps.

- **30 fps Frame Format** — This format is based on a frame rate of 30 frames per second. This is the original SMPTE format developed for monochrome (black & white) video, and is commonly used in audio-only applications.
- **29.97 Non-Drop Frame Format** — This format is used with NTSC color video. It runs at a slower frames per second rate of 29.97, but unlike 29.97 Drop frame time code, it makes no compensation for the discrepancies in "wall clock" time versus SMPTE time. It's important to note that "one hour" of 29.97 Non-Drop frame time code is actually one hour and 3.6 seconds of "real time" due to the fact that the slower frame rate does not match "wall clock."

*Note: There is sometimes confusion in the audio/video world regarding SMPTE terminology referring to the 30 fps (black & white video standard) or 29.97 fps (color video standard) frame rates. When working with NTSC video (the standard in North America), one generally works with the color video standard: either 29.97 fps Non-Drop or 29.97 fps Drop-frame.*

- **29.97 "Drop Frame" Format** — This format was developed for NTSC color video programs which need to remain in sync with "wall clock" time, and is commonly used in broadcast television. Since NTSC color video has an actual frame rate of 29.97 frames per second, this slight deviation from the standard 30 frames/second rate causes time code numbers to be out of sync with "wall clock" time, such that an hour of elapsed 29.97 frame rate SMPTE time code is not equal to one hour of real time due to the fact that the time code is actually running slower. To compensate for this discrepancy in frame rates, the first two frames of each minute are "dropped" (omitted) with the exception of every 10th minute. This results in 108 frames being dropped every each hour, exactly the number required to avoid accumulation error and thus reflect true "wall clock" in the time code clock values. (See the section *About Pull Up and Pull Down Sample Rates* next in this chapter.)
- **30 fps Drop Frame Format** — This format is used in film sync "pull-up" applications. (See the section *About Pull Up and Pull Down Sample Rates* next in this chapter.)
- **25 fps Frame Format** — This format is used with the European PAL video standard, which runs at a 25 fps frame rate. This format is also called the EBU (European Broadcast Union) format because it's used by broadcasters throughout most of Europe.
- **24 fps Frame Format** — This format is used exclusively for film applications. Film is often photographed and projected at a 24 fps frame rate, so this SMPTE format is useful when one time code frame should equal one film frame.

## About Pull Down and Pull Up Sample Rates

*Pull Up* and *Pull Down* are terms used to refer to the deliberate "miscalibration" of the audio sample rate clock (speed, or musical pitch) in order to compensate for a speed change elsewhere in the production chain. The usual situation in which these rates are encountered is when film footage (at 24 fps) is transferred to color NTSC-standard video tape (at 29.97 fps).

Using Pro Tools or AudioVision in *Pull Up* and *Pull Down* modes requires a Digidesign Universal Slave Driver, Digidesign SMPTE Slave Driver or third-party synchronizer that supports 256x clock output and *Pull Up* and *Pull Down* sample rates. (The Video Slave Driver does not support *Pull Up* mode.) *Therefore, when using the Universal Slave Driver with Pro Tools, Pull Up and Pull Down modes are not supported on Pro Tools Audiomedia and DAE PowerMix systems.*

***Consider the following scenario:***

If you have a film clip that lasts 1000 seconds, you would have 24,000 film frames (pictures). If you want to transfer that film to 1000 seconds worth of color videotape, you would have to "fit" your 24,000 film frames into 29,970.02997 video frames. Because you can't have a fraction of a picture, the best you could do would be to repeat a film frame occasionally to make up the difference in the frame counts. But if you did that, a fraction of a picture (the 0.02997 part) would be left over. Thus, this scheme wouldn't work.

When film is transferred to NTSC videotape, the solution is not to convert to the color video rate of 29.97 fps, but to use the black and white frame rate of 30 fps. You can then put 24,000 frames into 30,000 video frames evenly. This can be done by repeating certain *fields*. Every video frame has two fields, and every film frame has one field. If we have four frames of film, we can map them to five frames of video in the following way:

FILM FRAMES:
|A| |B| |C| |D|

VIDEO FRAMES (two fields/frame):
|AA| |BB| |BC| |CD| |DD|

This preserves the 4:5 ratio between the film sync rate of 24 fps and the video rate of 30 fps. Certain frames of video actually have two different fields from two different frames of film. This is call a *2-3 Pull Down*.

Unfortunately, NTSC color video decks don't play at 30 fps; they play at 29.97 fps. If you play your newly transferred tape on a normal video deck, the picture will run slightly slow. The audio will also run slowly, making the pitch flat. For example, if you were to record and edit this audio at 44.1 kHz and transfer the final edit to DAT, when the DAT to film transfer was done at 44.1 kHz, the resulting audio would be slower than the picture.

### Film Speed Versus Video Speed

Here are some important tips that may help you understand the requirements for and process used with film transfer Pull Up and Pull Down. When spotting audio to video that was transferred ("Telecine'ed") from film, there are two important terms to keep in mind: *film speed* and *video speed*. Film speed is a reference to audio that was recorded and plays back in synchronization with the film camera, and this audio is running at the same speed as the film camera or projector. Video speed is a reference to audio that is running at the same speed of the film transferred to video. As mentioned before, video speed runs at a slightly slower speed than film speed. These are the only two speeds you need to know. The essential question is "Do you want to work at film speed or video speed?" Remembering this simple question can make your life a lot easier!

If your goal is to edit and mix audio in Pro Tools or AudioVision and then lay back to a device that runs at film speed (such as Mag or Time Code DAT), you will need to *temporarily* slow down (or *Pull Down*) the audio in Pro Tools or AudioVision while you're working with film transferred to video, and then speed up the audio back to film speed when you're *finished*. This can be accomplished by pulling down the sample rate of the audio only *after* the audio has been recorded into Pro Tools or AudioVision.

For example, film speed audio from a Nagra® machine that is referenced to 30 fps time code is recorded into your Pro Tools or AudioVision system at a nominal sample rate of 44.1 kHz. Keeping in mind that film speed is faster than video speed, select 30 fps in your Pro Tools or AudioVision session and record in your audio online and referenced to the time code on the Nagra (as described in the Pro Tools and AudioVision User's Guides).

Once all the audio has been recorded, and you are locked to a video workprint (at "video speed"), you'll need to select Pull Down in two locations. First, select *Pull Down* on the front of your Universal Slave Driver, SMPTE Slave Driver, Video Slave Driver, or third-party synchronizer that supports 256x clock output and Pull Down sample rates. Secondly, enable *Pull Down* in Pro Tools' Session Setup Window (described in the SMPTE chapter in the *Pro Tools User's Guide*), or with AudioVision's *Pull Down Audio Tracks* command in the AudioVision menu. At this point, it is highly

recommended that you verify whether the video you're working with is striped with Drop Frame or Non-Drop Frame time code. While in Pull Down mode, you can work with your reference video and everything will remain in sync and run at the proper speed (assuming your system is completely resolved).

Once you are ready to lay back your completed project to an audio device running at film speed, deselect *Pull Down* from the Universal Slave Driver , SMPTE Slave Driver, Video Slave Driver or third-party synchronizer, and from Pro Tools' Session Setup Window or the AudioVision menu. Then change your time code frame rate in the Pro Tools or AudioVision session back to 30 fps. Once *Pull Down* has been deselected, the audio played back from Pro Tools or AudioVision will now synchronize perfectly with the edited film.

If you are working with video that was transferred from film and the final layback destination is video (or television), and you would like to provide a digital transfer to your clients, you will need to alter the above recipe slightly. Keep in mind that when you are working in *Pull Down* mode, your active sample rate is 44.056 kHz. However, most DAT machines do not record at this sample rate. In order to accomplish a Pulled Down sample rate of 44.1 kHz and remain synchronized to video tape, you will need to have your audio recorded at a Pulled Up sample rate of 44.144 kHz. After all the audio has been recorded into the Pro Tools or AudioVision system, deselect *Pull Up* on your hardware synchronizer. By deselecting *Pull Up*, the recorded audio is slowed down to synchronize with the video, while achieving a true playback sample rate of 44.1 kHz. Note that in order for this audio to ever match film speed, you will need to *Pull Up* the sample rate or playback speed of the playback device.

By using a Universal Slave Driver (or SMPTE Slave Driver) in conjunction with Pro Tools or AudioVision, you can perform a deliberate *Pull Up* or a *Pull Down* so that even a misprinted transfer can be used.

Similarly, a Video Slave Driver allows you to perform a deliberate *Pull Down* only. However, remember that you should always check with both the supplier and the receiver of your audio material to find out exactly what sample rate you should use.



## About Clock References

Understanding the second question that we posed a few sections ago, "How fast are we going?", can be a bit tricky. By "fast," we are referring to how long each frame of time code lasts. Let's look at a potential problem to understand why this is an issue.

Modern professional-quality gear is designed to have an accurate *internal clock* (which tells each device exactly how long a second or frame should last). However, different devices may be off by tiny fractions of time, especially those with mechanical transports, such as an audio or video tape recorder. Consequently, if we are dealing with a time code format of 30 frames per second, each frame should theoretically last just 1/30 of a second, but in fact, it may be off by a tiny fraction of time.

For example, let's say we have a video tape recorder (VTR) and a digital audio workstation (DAW). Logic would suggest that if we started playing both from a time code location of 01:00:00:00 and stopped them both once they reached 02:00:00:00, exactly one hour of "wall clock" (that is, "real time") would elapse. But in fact, it might take our VTR one hour and one-tenth of a second of real time to play from a time code reading of 01:00:00:00 to 02:00:00:00. And even though it's very accurate, our DAW might take only 59.9999999 minutes to play the same "hour." Even though these differentials may seem tiny, over the course of a television show or a feature-length movie, they can compound and lead to major timing errors.

The solution is to give every device in a studio the same *clock reference*, so that everything plays (or records) at the same speed. A typical clock reference that's found in almost every professional video editing studio—and many audio post-production studios—is a *video sync,* or *black burst* generator, which can be used to distribute *house sync*. A black burst generator has a built-in, very accurate clock that simply "ticks away" at a rate that is a hi-speed multiple of the desired video frame rate (30, 29.97, or 25 frames per minute). Devices that accept video sync input then "divide down" this reference signal to drive their reference clocks or transports. By connecting the output of the black burst generator to the external clock reference connector of all video editing systems, video decks, digital audio workstations, and other devices, everything will have a common clock reference and run at the same speed.

Keep in mind that a black burst generator doesn't generate time code or other positional information. Rather, it simply provides clock "speed" information, by "saying" to everything connected to it that "here's how long a frame lasts in this studio." Hence, the term "house sync."

The Universal Slave Driver can obtain its clock reference from any one of a variety of external sources:

- **Video** — sourced from a black burst generator, or a video signal from a VTR or video editing system.
- **LTC** — most typically this would be linear time code from an analog ATR.
- **Digital Clock** — in the form of Word Clock, Super Clock, or AES/EBU null clock, and usually generated from an external digital ATR, workstation, or mixing console. *(AES/EBU "null clock" refers to the fact that the audio information in the clock signal is ignored.)*
- **Pilot Tone** — a 50Hz or 60Hz clock reference typically used by Nagra and other audio recorders used for on-location film production. Pilot Tone references the frequency of the "wall socket" or "mains voltage," which is the exact frequency of the power source connected to your location recorder.
- **Bi-phase/Tach** — the electronic "pulses" used commonly by film mag recorders and other equipment.

In addition, the Universal Slave Driver can create its own clock reference, using:

- **Universal Slave Driver's Internal Clock** — a very accurate, crystal-referenced, internally generated clock.

## The Universal Slave Driver's Output Capabilities

As we mentioned earlier, the Universal Slave Driver can output both time code and clock reference signals.

As long as the Universal Slave Driver has a *positional* reference source (external time code or bi-phase, or internally generated time code), it can generate the following types of time code:

- **LTC** — most usually, for use with a reel-to-reel audio tape recorder, or for "striping" a videotape's audio (or cue) track with LTC.
- **VITC** — typically used with a VTR, nonlinear video editing system, or other external device capable of recording or reading VITC.

*Note: You must have a video signal in order to generate VITC. For more information, refer to the "Generating & Regenerating Time Code & Clock Information" sections in Chapters 3 & 4.*

- **MIDI Time Code (MTC)** — to provide an external MIDI interface or other third-party MIDI products with positional information.

As long as the Universal Slave Driver has a *clock* reference source (either external or internally generated), it can generate the following types of clock information:

- **Word Clock (1x)** — a clock reference signal that runs at a chosen audio sampling rate (typically either 44.1kHz or 48Hz). Used by a variety of digital audio tape recorders, digital mixing consoles, and digital audio workstations.
- **Digidesign Super Clock (256x)** — a high-quality clock reference signal that's similar to Word Clock, but which runs at 256 times the audio sampling rate. Used by all Digidesign Pro Tools audio interfaces, and also by most other types of "external" Pro Tools hardware.
- **AES/EBU Null Clock** — a clock reference signal that, like Word Clock, runs at the chosen audio sampling rate, but which uses a standard AES/EBU digital audio connector, rather than a dedicated clock connector. Also known as AES "digital black." Used with external digital audio devices that do not have dedicated Word Clock or Super Clock connectors, such as certain professional DAT recorders.

*Note: The Universal Slave Driver does not generate or pass any actual digital audio information via its AES/EBU connectors; rather, it only receives or generates the clock portion of the AES/EBU signal.*

Finally, the Universal Slave Driver has several other output capabilities:

- **Window Burn** — the ability to overlay, or "burn," a small window onto a video signal, showing time code readings. Typically the window is placed at the bottom of the video picture, and the time code readings are in "hours:minutes:seconds:frames." In most cases, the window dub readings correspond to a video signal's VITC time code values, or to LTC printed on the control or audio track.
- **GPI (General Purpose Interface)** — a specialized type of "trigger" switch that's common in broadcast and post-production applications. The Universal Slave Driver has six GPI outputs, as well as four GPI inputs. GPI capabilities include powering on studio record lights or audio cart machines. *(Look for GPI feature support, including GPI input implementation, in an upcoming release of Pro Tools software!)*
- **9-pin Pass-through** — the ability to pass machine control (and other RS-422 serial information) between the host computer and a "9-pin savvy" VTR (or other external device). Since the Universal Slave Driver occupies one of the Mac's serial ports (when used with the USD Setup software), the 9-pin pass-through port gives users of Digidesign's optional MachineControl software for Pro Tools software (as well as other machine control software) another way to connect to their serially controlled devices to their Mac. This also frees up your other serial port for connection to a multi-port interface for MIDI equipment.

## Conclusion

By now you should understand your Universal Slave Driver's basic capabilities and requirements. In the next chapter, we'll review how to connect the Universal Slave Driver to the rest of your studio.

# Integrating the Universal Slave Driver Into Your Studio

# Integrating the Universal Slave Driver Into Your Studio

2

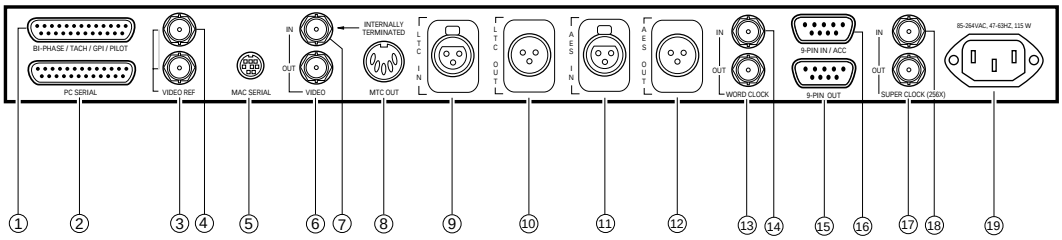
## Introduction

In this chapter we'll describe the Universal Slave Driver's connections to external time code and clock reference sources, Digidesign audio workstations (such as Pro Tools), Macintosh CPUs, and other components in the typical audio post-production studio. We'll also describe how to install the USD Setup software.

*Note: This chapter provides information for how to connect your Universal Slave Driver to other components in your studio. For more detailed definitions of terms, and information about which connection you should be using for a particular application, please refer to Chapter 3 and Appendix I.*

Turn to the next page for a description of each connector on the rear panel of the Universal Slave Driver.

## Rear Panel Overview




**1. Bi-phase/Tach/GPI/Pilot port ("Accessory" port)**

With a properly wired cable, this serves as inputs for Bi-phase, Tach and Pilot signals. This connector is also used for GPI input, output and thru signals. Used only for specialized applications.
*Connector: DB-25 female.*

*Note: Please refer to Appendix I for wiring information and other specifications for this port.*

**2. PC Serial port**

A bidirectional (in/out) port is designed for use exclusively with a PC-compatible host computer; Macintosh users will use the Mac Serial port, as described below. *(Support for this port will be implemented in a future software release.)*
*Connector: Female DB-25.*

**3. Video Reference In**

Receives a signal from a video source, such as a black burst (house sync) generator or a standard video signal, for clock reference purposes only.
*Connector: Female BNC.*

*Note: If you wish to insert a Window Burn onto a video signal, you should input the signal to the Video In connector rather than the Video Ref In connector.*

*User Tip: If you are using only a single video source (such as a work print) for clock reference purposes, make the following cable connections. Connect your video signal to the Video Ref In port, the Video Ref Thru port to the Video In port, and then the Video Out port to other video devices. In this way, you can make a Window dub, while using the same video source signal as the "video reference."*

**4. Video Reference Thru**

A parallel, unbuffered connection output for any video source connected to Item 3; allows black burst or other video reference to be passed onto another device. Continues to output whatever signal is present at Item 3 regardless of whether or not the Universal Slave Driver is powered up.
*Connector: Female BNC.*

*Note: If the Universal Slave Driver is the last device in the video sync chain, a BNC Terminating Plug (supplied) must be attached to this connector.*

#### 5. Mac Serial Port

A bidirectional (in/out) port designed for use exclusively with a Macintosh (or compatible Macintosh-clone) host computer. If you're using USD Setup software, or you're using the Universal Slave Driver with a Digidesign or Avid audio workstation, you should connect your Mac to this port using the Universal Slave Driver's Host CPU Cable (included).
*Connector: Female mini DIN-8 (8-pin).*

#### 6. Video In

Receives a signal from an NTSC/PAL video source. This source can serve as an alternative video clock reference (selected using the USD Setup application), and can also serve as a positional reference (assuming the video signal is striped with VITC). Also, if you wish to "burn" a VITC window dub onto a video signal, the signal should be connected to this port. This connector is internally terminated at 75 ohms.
*Connector: Female BNC.*

#### 7. Video Out

Serves as a video output for NTSC/PAL video source. If the Universal Slave Driver is configured to overlay a VITC or a window dub onto the video signal, then the output signal from this connector will contain the window dub. This output is also used when the Universal Slave Driver is outputting VITC, which can be generated internally if a video signal is present, or which can be converted from an external clock or positional reference. Termination is not required for this connector.
*Connector: Female BNC.*

#### 8. MTC Out

Outputs MIDI time code, in parallel with the Universal Slave Driver's LTC output. Also outputs MTC when the Universal Slave Driver is reading VITC (*unlike* the LTC Out connector).
*Connector: Female mini DIN-5.*

#### 9. LTC In

Receives a linear time code source, in balanced or unbalanced analog audio format, for either clock reference or positional reference or both simultaneously. Most commonly, this source will be from an audio tape track, or from an audio "cue" track from a VCR.
*Connector: Female XLR-style 3-pin*
*(Pin 2 "+" or "hot," Pin 3 "–" or "cold").*

#### 10. LTC Out

Outputs linear time code, in balanced or unbalanced analog audio format, which can be generated internally, or which can be converted from an external clock or positional reference.
*Connector: Male XLR-style 3-pin*
*(Pin 2 "+" or "hot," Pin 3 "–" or "cold").*

*When the LTC Out port is connected in unbalanced mode, Pin 3 must be grounded. Refer to the wiring diagrams in the "Making Signal Connections to the LTC Input and Output" section later in this chapter.*

#### 11) AES/EBU In

Receives an AES/EBU digital signal, for clock reference purposes only. The Universal Slave Driver recognizes only AES/EBU "null clock" information, not the audio signal. If digital audio information is supplied to this input, it will be "stripped off" and ignored.
*Connector: Female XLR-style 3-pin*
*(Pin 2 "+" or "hot," Pin 3 "–" or "cold").*

#### 12. AES/EBU Out

Outputs an AES/EBU digital null clock only, without any audio information.
*Connector: Male XLR-style 3-pin*
*(Pin 2 "+" or "hot," Pin 3 "–" or "cold").*

#### 13. Word Clock In

Receives "ordinary" (1x sample rate) Word Clock information, as is transmitted by a variety of third-party digital audio devices. Used for clock reference purposes only.
*Connector: Female BNC.*

#### 14. Word Clock Out

Outputs 1x sample rate Word Clock information, for clock reference purposes only. Can be generated internally, or can be converted from an external clock reference.
*Connector: Female BNC.*

#### 15. 9-pin In/Acc
#### 16. 9-pin Out (9-pin Pass-through)

Forward data to or from the Macintosh Serial or PC Serial ports; used for exchanging data between the "host" computer and external serially controlled equipment. The actual function of these ports is determined by software running on the host computer; in fact, either port can be configured as an input or output, depending upon the software. Most typically used for machine control of VTRs and DAT recorders with Digidesign's AudioVision application, or the optional MachineControl software for Pro Tools.
*Connector: Female DB-9.*

#### 17. Super Clock In (Slave Clock In)

Receives Digidesign's high-quality Super Clock (256x sample rate) information, as transmitted by Digidesign 882 I/O and 888 I/O audio interfaces and other devices including the Digidesign SMPTE Slave Driver and Video Slave Driver. Used for clock reference purposes only. *(Also known as "Slave Clock In," as labelled on other Digidesign hardware devices.)*
*Connector: Female BNC.*

#### 18. Super Clock Out (Slave Clock Out)

Outputs Digidesign's high-quality Super Clock (256x sample rate) information, for clock reference purposes only. Can be generated internally, or can be converted from an external clock reference. *(Also known as "Slave Clock Out," as labelled on other Digidesign hardware devices.)*
*Connector: Female BNC.*

#### 19. AC Power In

Receives AC mains power, 85 to 264 volts, 47 to 63 Hz (auto-switching).
*Connector: IEC Standard AC Power Cable (3-conductor).*

## Connecting a Macintosh Host CPU

Most users will want to use a compatible Macintosh computer as the "host" for their Universal Slave Driver. This way, using the included USD Setup software, the Macintosh can be used to control every aspect of the Universal Slave Driver. (Neither a Mac nor USD Setup software are required to access many of the Universal Slave Driver's features; still, they offer the easiest and most comprehensive control over all of the Universal Slave Driver's features.)

For a complete description of the Macintosh host computer's requirements, please see Chapter 1.

#### A Special Note For Windows Users

This manual is written with Macintosh users in mind. However, the Universal Slave Driver can also be operated with Windows-compatible systems such as Digidesign's Session 8, using the Universal Slave Driver's front panel controls.

## About the Host CPU Cable

The Universal Slave Driver includes a 4 meter (approximately 12 foot) cable, designed to connect to a Macintosh host computer. Please note this cable has standard Mac serial connectors—the same as you would expect to find on an ordinary printer cable—but internally, the cable is wired differently from an ordinary serial cable. Similar to many modem-specific cables, the Universal Slave Driver's Host CPU Cable supports "hardware handshaking."

If you choose to use a longer cable, be sure it supports hardware handshaking; if you need to make your own cable, please refer to the wiring specifications in Appendix I in the end of this manual.

***To connect the host CPU cable:***

1. Make sure the power is switched off for both the Universal Slave Driver and the Macintosh.
2. Connect the other end of the cable to the Mac Serial port of the Universal Slave Driver.
3. Connect one end of the cable to one of the Mac's serial ports.
4. Restore power to the Universal Slave Driver, and restart the Mac. This would be a good time to install the USD Setup software and to configure the serial port, as described next in Chapter 3.

*Note: If you are an OMS user, make sure the serial port (modem or printer) connected to the USD is not being used by OMS. To do this, choose the OMS MIDI Setup command from OMS' Edit menu to open the OMS MIDI Setup dialog, uncheck the checkbox for the serial port connected to the USD which will disable its use by OMS. Then click OK to close the OMS MIDI Setup dialog.*

*If you are a FreeMIDI user, make sure the serial port (modem or printer) connected to the USD is not being used by FreeMIDI. To do this, choose the FreeMIDI Preferences command from FreeMIDI's File menu to open the FreeMIDI Preferences dialog, uncheck the checkbox for the serial port connected to the USD, which will disable its use by FreeMIDI. Then click OK to close the FreeMIDI Preferences dialog.*

If a serial port is not readily available for use with the Universal Slave Driver, the most reliable solution is to disconnect any cables which are not essential while you're using the Universal Slave Driver, such as a printer or AppleTalk cable. Alternatively, if you've connected a 9-pin-compatible VTR or other device to your Mac serial port, you can disconnect it and reconnect it to the Universal Slave Driver's 9-pin Pass-through port. You may also consider using a serial port expander; some Digidesign users report good results with Port Juggler™ from Momentum, but be advised that some MIDI interfaces may experience problems when connected to a serial port expander.

If a direct serial connection simply cannot be made from the Universal Slave Driver to the host CPU, remember that the Universal Slave Driver may be used in "stand-alone" mode. The most often used parameters in the Universal Slave Driver can be accessed from the front panel controls. Even if you find yourself having to use the USD Setup application to first get started, the Universal Slave Driver will remember your remote parameter settings in stand-alone operation.

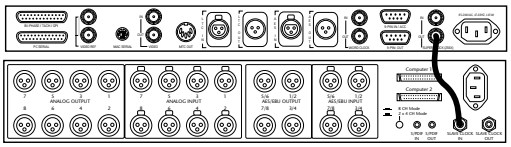
In stand-alone operation, positional information from the Universal Slave Driver would be transmitted to Pro Tools (or other time code-capable software) using a MIDI interface. Be sure to connect the Universal Slave Driver's MTC Out connector to an input on your MIDI interface which should be connected directly to one of the host CPU's serial ports. For instructions on how to do this, refer to the "Connecting the Universal Slave Driver to a MIDI Interface" section later in this chapter.

## Connecting a Digidesign Audio Workstation

As we described in Chapter 1, the Universal Slave Driver allows certain Digidesign audio workstations to sync to a variety of clock and time code sources. In particular, the Universal Slave Driver is a powerful complement to Digidesign audio workstations that utilize an external audio interface, such as any Pro Tools system equipped with an 888 I/O or 882 I/O audio interface.

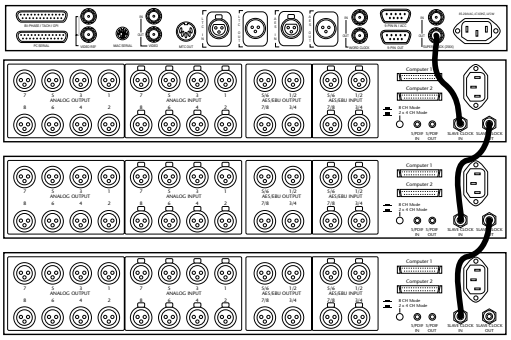
***To connect the Universal Slave Driver to a compatible Digidesign audio interface:***

- Connect the *Super Clock Out* of the Universal Slave Driver's to the *Super Clock In* (or *Slave Clock In*) of any compatible Digidesign audio interface.



*Super Clock (Slave Clock) connection from the USD to the 888 I/O Audio Interface*

- If your Digidesign workstation uses more than one interface, simply connect the Universal Slave Driver's *Super Clock Output* to your first interface. Then "cascade" the Super Clock information to any additional interfaces by connecting the first interface's *Super Clock Out* (or *Slave Clock Out*) to the *Super Clock In* (or *Slave Clock In*) of the next interface. Repeat this connection scheme until all interfaces are part of the Super Clock "chain."



*Super Clock (Slave Clock) "chain" connection from the USD to multiple 888 I/O Audio Interfaces*

Please keep in mind that while the Universal Slave Driver transmits clock reference information directly to Digidesign audio interfaces, it does not transmit positional (time code) information directly to them. Rather, the Universal Slave Driver transmits positional (time code) information using the MTC Out connector which sends the time code to the Macintosh via a MIDI interface. *(The MIDI interface will no longer be needed when Universal Slave Driver functions are integrated in an upcoming release of Pro Tools.)*

Most other Digidesign hardware does not need to be connected to your Universal Slave Driver. These products—such as Pro Tools audio cards, DSP Farms, and the R1 and ProControl remote control surfaces—either receive their clock information indirectly from a Digidesign audio interface, or they don't need to be synchronized to an external clock.

### Using the Universal Slave Driver With Other Digidesign Software

It is possible to use the Universal Slave Driver with certain other Digidesign software programs, but in a limited way. These programs include:

- Pro Tools PowerMix (using either the Mac's internal sound inputs/outputs, or a Digidesign Audiomedia II or III card);

- Sound Designer II; and
- Session Software.

With these programs, the Universal Slave Driver can be used to provide location information (termed *Positional Reference* on the Universal Slave Driver), via a MIDI interface to the Macintosh. However, unless you are using these programs with a Super Clock-equipped Digidesign audio interface, there's no way for the Digidesign software to receive continuous clock information (the *Clock Reference* on the Universal Slave Driver). Consequently, it's possible for your sessions to drift out of sync with the Universal Slave Driver's source, especially, if your working with sessions that last longer than a minute or two, or if you have a relatively unstable source (such as an audio tape recorder).

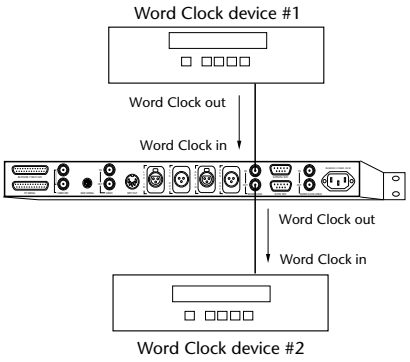
For these reasons, the Universal Slave Driver is probably not the most cost-effective synchronizer for these programs. Unless you have an unusual need for one of the Universal Slave Driver's translation capabilities, you'll probably be better off using a less complicated and less expensive positional reference source that uses MIDI Time Code (MTC), such as Mark of the Unicorn's MIDITimePiece II, or Opcode System's Studio 3 or Studio 4.

## Using the Universal Slave Driver with the Tascam DA-88 and Other Word Clock-Compatible Digital Audio Devices

Many professional digital audio products—including open-reel multitrack tape recorders, digital mixing consoles, and digital workstations from other companies—have Word Clock (1x sample rate) connectors. One of the most popular such devices is the Tascam DA-88 8-track modular digital multitrack.

Word clock allows the DA-88 (and other Word Clock-compatible devices) to send or receive external clock information, which controls the sample rate, which in turn (where applicable) controls the play and record speed.

The primary difference between Word Clock and Digidesign's proprietary Super Clock is the rate: Word Clock runs at one-times (1x) the actual sample rate (typically 48 kHz or 44.1 kHz); Super Clock runs at 256-times (256x) the sample rate, and is consequently more precise. Like Super Clock, however, it is possible to create a "chain" of digital devices in your studio, by picking one source as the Word Clock master, and configuring other sources as Word Clock slaves.



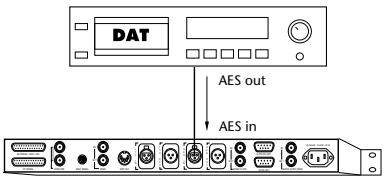

*Connecting the USD to Word Clock devices*

The Universal Slave Driver has both Word Clock inputs and outputs, allowing it to act as a Word Clock master or slave. Keep in mind that Word Clock contains no positional information; if you want devices to play or record in sync, you'll still need to provide them with time code information.

## Connecting the Universal Slave Driver with Devices that Require AES/EBU Null Clock

If you are using a device such as a DAT machine that has an AES/EBU or S/PDIF port, and you wish to use this device as clock reference for your Pro Tools system, simply connect your device to your Pro Tools audio interface's digital I/O ports (of either standard). Both AES/EBU and S/PDIF include an imbedded word clock in addition to the audio data stream. By using the "digital sync" option in Pro Tools, you can resolve to the device's sample clock. (That is, if the device's speed varies at all, the imbedded clock in the AES/EBU stream will follow accordingly.) If you then output audio to other destinations via your audio interface's digital outputs, *they* will pass along this clock reference information, keeping all system components resolved together.

Similarly, in order for the Universal Slave Driver to use one of these devices as a clock reference, all you need is to connect the device's AES/EBU output to the Universal Slave Driver's AES/EBU input. The Universal Slave Driver has a AES/EBU "null clock" input, meaning that all audio information that may be present at its input is stripped off, and only the clocking information is passed through.




*AES/EBU Out from a DAT Recorder to the AES/EBU In on the Universal Slave Driver*

However, note that most professional DAT machines *do not* support AES/EBU "null clock" or "black" as a clock reference, but they *do* support the use of video house sync. Professional time code DAT machines use their time code reader input as the *positional reference* for the machine, and their AES/EBU audio port as the *clock reference* for the system, unless they are locked to an external sync source such as video.

Some professional digital audio products are beginning to use AES/EBU "null clock" (which is an AES/EBU data stream that contains only clock information and no audio information) as a *system clock reference source*. These systems would then rely upon a single AES/EBU master clock source that is distributed throughout a digital audio facility, in much the same manner that house sync is distributed throughout a video facility. If you are connecting the Universal Slave Driver to such a system, you will want to use the Universal Slave Driver's AES/EBU input as the clock reference connection, so that all system components are referencing the same time base.

## Making Signal Connections to the LTC Input and Output

The Universal Slave Driver's LTC In and LTC Out connectors are balanced XLRs with Pin 2 wired "+" or "hot," Pin 3 wired "–" or "cold," and Pin 1 wired to ground (shield). Depending on whether you are connecting a *balanced* or *unbalanced* signal to these connectors, different wiring configurations are recommended for optimum signal integrity, especially for long cable runs.

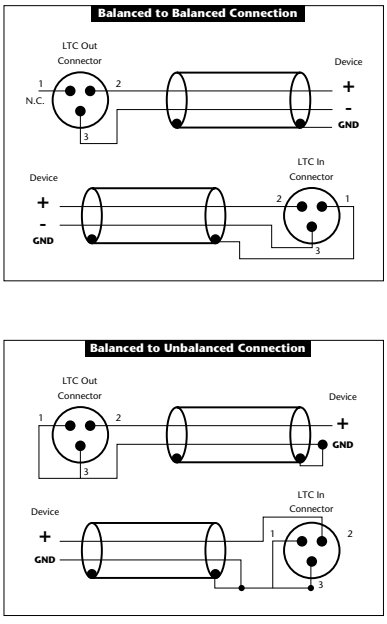
If you are connecting a *balanced* signal to the Universal Slave Driver's LTC In or LTC Out connectors:

- Pin 1 and ground should be connected at the input only (*not* at the output). This will prevent ground loops between the shield and the Pin 1 conductor.

If you are connecting an *unbalanced* signal to the Universal Slave Driver's LTC In or LTC Out connectors:

- Connect only Pin 2 to the "+" signal;
- Connect both Pins 1 and 3 to ground at all inputs and outputs.

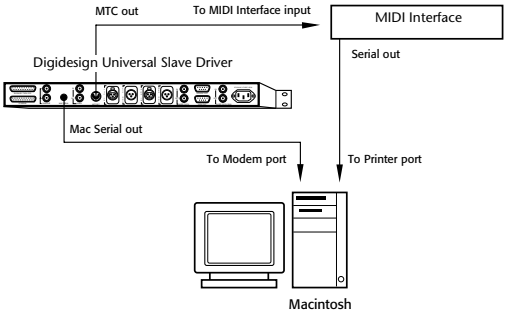
Refer to the following illustration for the correct wiring diagrams.




*Wiring diagrams for the Universal Slave Driver's LTC In and LTC Out connectors*

## Connecting the Universal Slave Driver to a MIDI Interface

For live theatre sound or other specialized applications, the Universal Slave Driver can generate MIDI time code. To use this feature, the Universal Slave Driver's MIDI Output port should be connected to an appropriate MIDI input, using a standard MIDI cable. Optionally, the Universal Slave Driver's Mac Serial Out can be connected to an available serial port, using a standard serial cable, to remotely control the Universal Slave Driver using the USD Setup application.




*Connecting the USD's MTC output to MIDI Interface input*

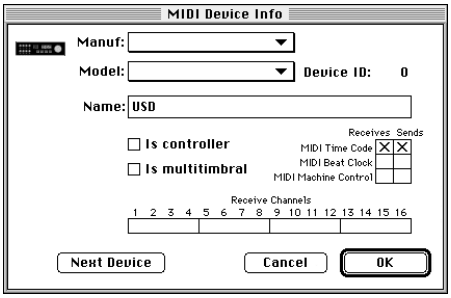
### Configuring the Universal Slave Driver for OMS

If you are an OMS user, you must create an *OMS device* for the Universal Slave Driver in OMS, in order for the MIDI interface to receive time code from the Universal Slave Driver.

This section assumes you have a basic working knowledge of OMS and its operating conventions, including connecting MIDI interfaces, creating OMS Studio Setup documents, configuring OMS drivers, defining and connecting MIDI devices. If you need to review details on working with OMS, refer to your OMS User's Guide.

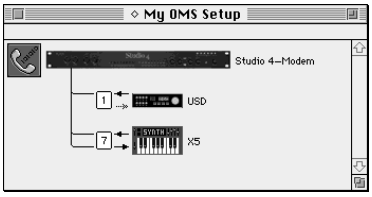
***To create an OMS Device for the Universal Slave Driver:***

1. Launch the OMS Setup application. The current OMS Studio Setup window appears.
2. From the Studio menu, choose the *New Device* command.
3. In the MIDI Device Info window that appears, leave blank the Manufacturer and Model names and name the device *USD*.
4. Uncheck both *Is Controller* and *Is Multitimbral*.
5. Check both *Receives* and *Sends MIDI Time Code*.
6. Uncheck *Receives* and *Sends MIDI Beat Clock*, and *Receives* and *Sends MIDI Machine Control*.
7. Leave the *Receive Channels* field unchecked.




*Defining the Universal Slave Driver as an OMS MIDI Device*

8. Click *OK* to close the MIDI Device Info window, and save the changes to your current OMS Studio Setup document.
9. Back in the OMS Studio Setup window, connect the Universal Slave Driver to the appropriate MIDI interface. To do this, click with the mouse and drag the *USD* icon over the icon for the MIDI interface, and release the mouse.
10. Arrows connecting the *USD* icon to and from the MIDI interface signifies a connection has been made. However, since the Universal Slave Driver does not have a MIDI input port, the OMS Studio Setup also does not require a software connection coming from the MIDI interface and going to the *USD* icon. Click the arrowhead of the line directed towards the *USD* icon. The arrowhead turns grey and the line disappears, indicating the connection is no longer active.




*Connecting the Universal Slave Driver to the appropriate MIDI interface in the OMS Studio Setup window*

11. Multiport MIDI interfaces (such as Opcode's Studio 4) will display a MIDI port number assigned to the connection between the *USD* icon and the MIDI interface. To change the port number to reflect the appropriate port the Universal Slave Driver is connected to the MIDI interface, click and hold down the mouse on the port number, drag the mouse up/down to raise/lower the value, and release the mouse. If you have only a standard MIDI interface (such as Opcode's Studio 3), then the OMS Studio Setup window won't display any port numbers for that interface.
11. If you are using the USD Setup to control the Universal Slave Driver via a direct serial connection, make sure the serial port (modem or printer) connected to the USD is not being used by OMS. To do this, choose the *OMS MIDI Setup* command from the Edit menu to open the OMS MIDI Setup dialog, uncheck the box for the serial port connected to the USD, then click *OK* to close the OMS MIDI Setup dialog.

*If you are running Pro Tools and you are using Opcode Systems' Studio 5 MIDI interface, you must set the latter to "Emulate MTP" mode to be fully compatible with Pro Tools.*

*If you are running Pro Tools, make sure Serial DMA is not being used by OMS. To do this, choose the Preferences command from OMS' Edit menu to open the Preferences dialog, uncheck the Use Serial DMA option box, then click OK to close the Preferences dialog.*

## Installing the USD Setup Software

The USD Setup software is an easy-to-operate Macintosh application that gives you complete remote control, via your computer, of all your Universal Slave Driver's capabilities.

Unlike many other Digidesign applications, USD Setup does not require DAE, DigiSystem INIT, or other Digidesign control panels and extensions, nor does it require any Digidesign hardware (other than, of course, the Universal Slave Driver and the special hardware-handshaking serial cable that's included with the Universal Slave Driver). Please see Chapter 1 for a complete listing of systems requirements.

***To install USD Setup:***

1. Insert the *USD Setup* installer disk into your disk drive.
2. Double-click on the file *Release Notes for USD Setup*, to read any last-minute changes or other notes.
3. Drag the application *USD Setup* file from the installer disk to your computer's hard drive and a copy will be made. For convenience, we recommend placing the application in the *Digidesign* or *Avid* folder on your computer's hard drive. If you don't have such a folder, just create a new folder called *USD Setup*.

## Conclusion

Now that you've finished connecting the Universal Slave Driver to the rest of your studio equipment and installing the USD Setup software, turn to the next chapter to learn how to use the USD Setup software to control your Universal Slave Driver.

# Operating the Universal Slave Driver Using USD Setup Software (Remote Control)

# Operating the Universal Slave Driver Using USD Setup Software (Remote Control)

3

## Introduction

In this chapter, we'll describe how to operate your Universal Slave Driver using USD Setup software (included with your purchase of the Universal Slave Driver).

USD Setup offers the most straightforward way for you to configure and operate your Universal Slave Driver. Since it replicates all of the Universal Slave Driver's front panel controls (and even provides additional features), it also allows you to control your Universal Slave Driver remotely from a wide range of Macintoshes.

Please see Chapter 1 for a complete listing of USD Setup's computer requirements, including the Mac serial cable requirements. Also, please be sure to refer to Chapter 2 for instructions on how to install USD Setup.

*Tip: Much of the information that's included in this chapter is repeated in Chapter 4, "Operating the Universal Slave Driver Using its Front Panel Controls." Since users will be operating the Universal Slave Driver using either the USD Setup software or the front panel controls, we've organized the User's Guide in this fashion so that pertinent information will be close at hand, regardless of which method you use to operate your Universal Slave Driver.*

## How to Use This Chapter

This first half of this chapter is a reference section for the USD Setup software—offering a basic description of what each control is, where it's located, and where applicable, how to operate it. We suggest you refer to this part to familiarize yourself with the USD Setup software, and whenever you need a quick "refresher" on which control does what.

The second half of this chapter is more tutorial-oriented, with more detailed discussions of how the controls operate, and which settings and parameters to use in difference circumstances. We suggest you refer to this part to gain an in-depth understanding of the USD Setup's controls and applications.

## Using the USD Setup Software in Conjunction with the Universal Slave Driver's Front Panel Controls

If you are controlling your Universal Slave Driver with USD Setup software, and you have selected the default *Remote-Only Mode (Front Panel Lockout)* in the software's *USD Setup Preferences* window, then none of the Universal Slave Driver's front panel controls will be operational. Control of the Universal Slave Driver would be only accessible *remotely* from USD Setup. Additionally, if you are using USD Setup to control the Universal Slave Driver which is installed in your machine room, locking out the front panel will prevent someone from inadvertently changing the Universal Slave Driver's front-panel settings.

Keep in mind that even if you've chosen *Remote-Only Mode (Front Panel Lockout)*, the front panel LED Time Code Display—and all of the status LEDs—will reflect the whatever settings you've selected using USD Setup. The *Remote Only* LED will also light up.

*User Tip: By simultaneously holding down the Clock Reference, Positional Reference, and Frame Rate front-panel switches, you can disengage the Universal Slave Driver from Remote-Only Mode. This is useful when the host CPU is not easily accessible to override Remote-Only Mode.*

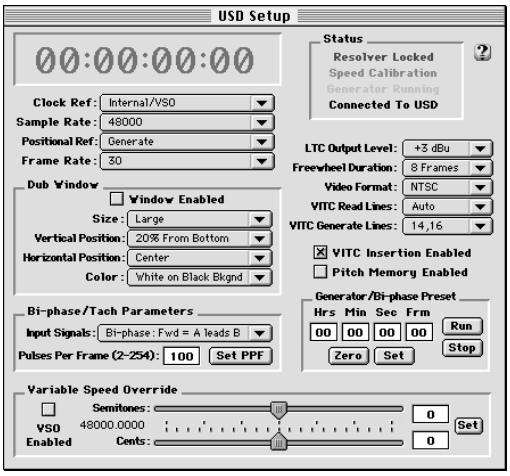
On the other hand, if you have not selected *Remote-Only Mode (Front Panel Lockout)*, then you will be able to operate the Universal Slave Driver using *both* USD Setup and the front panel controls. In this situation, when you make a change in one place (in USD Setup or the front panel controls), it "updates" the other. For example, if you change the clock reference using the front panel Clock Reference switch, USD Setup's *Clock Ref* pop-up menu will reflect the change.

## Regarding the Universal Slave Driver's GPI Trigger I/Os

Configuring and operating the Universal Slave Driver's General Purpose Interface (GPI) features requires specialized Macintosh software. GPI trigger features are planned for future for an upcoming Pro Tools release. Currently neither USD Setup nor the Universal Slave Driver's front panel controls are able to access the GPI features.

## A Tour of the USD Setup Window

The USD Setup application has just one main window, which appears when the program is launched:




*The USD Setup application window*

*Note: Your settings for this window may appear differently from this illustration—depending upon whether your Universal Slave Driver is connected to your Mac and powered up, and what the Universal Slave Driver's front-panel settings are at the time of launching the USD Setup application. For now, don't worry about these differences, since we'll be reviewing the details of how to re-configure the USD Setup in the coming sections.*

**1. Time Code Window**

Replicates the LED Time Code Display on the Universal Slave Drive's front panel. Its readings (in hours:minutes:seconds:frames) reflect the time code address of the current positional reference (internal or external).

The front panel LED Time Code Display will also show which video field is providing the VITC positional information (at slow crawl speeds). For instance, when you're jogging a videotape slowly from frame to frame, or when you "park" the videotape on a particular frame, it may be useful for you to know which of that frame's two video fields you're reading.

To facilitate this in USD Setup, the punctuation between "seconds" and "frames" may change. When the Universal Slave Driver is reading odd-numbered fields, the punctuation changes from a normal colon (":") to a period ("."); when it's reading even-numbered fields, the punctuation returns to a colon (":"). Note that this field identification feature is operational only while reading VITC, and then only when VITC is in a speed range from zero to about 75% of playback speed.

**2. Clock Reference**

Used to select the Universal Slave Driver's clock reference. The external clock reference choices include:

- Video (Video Reference Input);
- Video (Video Input);
- Linear Time Code (LTC);
- Digital (AES/EBU);
- Digital (Super Clock);
- Digital (Word Clock);
- Pilot Tone; or
- Bi-phase/Tach.

Alternately, the clock reference can be set to *Internal/VSO*, which uses the Universal Slave Driver's internal crystal-referenced clock and enables Variable Speed Override capabilities (covered shortly).

**3. Sample Rate**

Used to select the desired audio sample rate. The two primary choices are *48000* (48 kHz) or *44100* (44.1 kHz); either rate can also be set for *Pull Up* or *Pull Down*, to compensate for film-to-NTSC video transfers (as described in Chapter 1).

**4. Positional Reference**

Used to select the Universal Slave Driver's positional reference. The external positional reference choices include:

- Linear Time Code (LTC);
- Vertical Interval Time Code (VITC);
- Auto Switch LTC/VITC; or
- Bi-phase/Tach.

Alternately, the positional reference can be set to *Generate*, which is used for generating time code internally (with the Universal Slave Driver as the master time code source).

In *Auto Switch LTC/VITC* mode, the Universal Slave Driver will read whichever time code is providing the most accurate address (since VITC presents reading problems at high tape speeds, and LTC cannot be read when the external device is paused).

When *LTC* or *VITC* (or *Auto Switch LTC/VITC*) is chosen for positional reference, the Universal Slave Driver will regenerate time code that corresponds directly to the incoming LTC or VITC.

*Note: The Universal Slave Driver can regenerate VITC only when the positional reference is set to Generate, LTC or Bi-phase.*

*Note: The MTC Out connector will periodically output MTC when the Universal Slave Driver is reading VITC. This effectively allows you to use the Universal Slave Driver as a VITC-to-MTC convertor.*

When *Bi-phase/Tach* is chosen for positional reference, then the Universal Slave Driver will generate time code in relation to the Generator/Bi-phase Preset value (see the section on Bi-phase/Tach Parameters later in this chapter).

**5. Frame Rate**

Used to select the frames-per-second (fps) rate of external (or internally generated) time code. You can choose any one of the standard time code frame rates, including:

- 30 fps;
- 30 fps drop-frame;
- 29.97 fps;
- 29.97 fps drop-frame;
- 25 fps; or
- 24 fps.

**6. Status**

Shows current state of USD Setup software in relation to external devices, including the Universal Slave Driver. Indicators include:

- *Resolver Locked* — highlighted when the Universal Slave Driver is locked to the chosen external clock reference, or to its "Internal" clock reference.
- *Speed Calibration* — highlighted when the Universal Slave Driver's system clock and all output clocks are at a frequency that corresponds with the chosen sample rate. If the incoming clock reference is running moderately off-speed (for instance, if LTC is the selected clock and the LTC source is running faster than the nominal rate), this indicator will flash quickly (if too fast) or slowly (if too slow). The Speed Calibration indicator will be lit steadily only if the incoming clock is within ± 0.025% (250 parts per million) of accurate playback speed. If the speed variation is greater than +0.025%, the indicator will flash quickly; if the speed variation is less than –0.025%, the indicator will flash slowly.

*Note: Relatively new professional ATRs should be able to play back with a speed deviation of less than –0.025%. Some ATRs, even when calibrated properly, may not be able to run at an exact enough play speed to cause the Speed Calibration to remain highlighted without flashing. In general, users of semiprofessional or older ATRs should not be alarmed if Speed Calibration does not remain highlighted (assuming there are no problems with the ATR, such as a mis-calibrated motor, or an exceptional amount of "gunk" on the heads or tape path).*

- *Generator Running* — highlighted when the Universal Slave Driver is regenerating time code at its video, LTC, and MTC outputs in sync with the incoming positional reference source. Also highlighted whenever the Universal Slave Driver is generating time code internally.
- *Connected to USD/Waiting for USD/ Port Relinquished*:

  *Connected to USD* — highlighted whenever the Universal Slave Driver is powered on and connected properly to the Macintosh.

  *Waiting for USD* — highlighted whenever the Universal Slave Driver is powered down, or if the Universal Slave Driver is not properly connected to the Mac.

  *Port Relinquished* — highlighted if the USD Setup application is not currently communicating with the Universal Slave Driver, e.g. switched to the background. Simultaneously, the Universal Slave Driver releases the assigned serial port (*modem* or *printer*). This way, if you switch to Pro Tools from USD Setup, Pro Tools will be able to assume control of the serial port.

**7. LTC Output Level**

Used to adjust the analog audio level of the Universal Slave Driver's LTC output, from –24 dBu to +9 dBu.

**8. Freewheel Duration**

Sets the period of time for which the Universal Slave Driver will continue to generate time code when incoming time code is interrupted (due to tape drop outs or other errors).

Let's say for instance, our time code rate is 29.97 fps, and we've set a Freewheel Duration of 28 frames. With these settings, incoming time code could drop out for nearly a second, and the Universal Slave Driver would freewheel—that is, continue to generate time code. If the incoming time code were restored before 28 frames elapsed, the Universal Slave Driver would carry on generating time code as if nothing happened. However, if the incoming LTC signal was not be restored in time, the Universal Slave Driver would stop generating time code after 28 frames. The Freewheel Duration is adjustable from 4 frames to 40 frames.

**9. Video Format**

Selects the format for both the incoming and outgoing video signals. The two choices are *NTSC* (for North and South America, Japan, and certain other parts of the world) and *PAL* (for most of Europe, Asia, and Africa). Users of SECAM video (for France, Russia, and certain other parts of the world) should select *PAL*.

*Note: Please be sure you have selected the correct video format! The Universal Slave Driver will not warn you if you have chosen the wrong one.*

#### 10. VITC Read Lines

Determines which line pair of the incoming video signal the Universal Slave Driver "looks to," in order to read VITC. When set to *Auto*, the Universal Slave Driver will search for the first valid line pair automatically. Alternatively, this value can be set to one of the following line pairs:

- *10/12*
- *11/13*
- *12/14*
- *13/15*
- *14/16*
- *15/17*
- *16/18*
- *17/19*
- *18/20*
- *19/21*
- *20/22*

#### 11. VITC Generate Lines

Determines the line pair of the outgoing video signal onto which the Universal Slave Driver inserts VITC. Normally, this should be left at the default (and preferred) setting of *14/16*. The available line pairs include:

- *10/12*
- *11/13*
- *12/14*
- *13/15*
- *14/16*
- *15/17*
- *16/18*
- *17/19*
- *18/20*
- *19/21*
- *20/22*

#### 12. VITC Insertion Enabled

When selected, VITC will be inserted onto the outgoing video signal—assuming that a video signal is present at the Universal Slave Driver's video input, and that the Universal Slave Driver is in a valid mode for inserting VITC (as described later in this chapter).

#### 13. Pitch Memory Enabled

When selected, the Universal Slave Driver will remain at a "pitch" (i.e. sample rate) that corresponds to the last known incoming time code speed. When deselected, the Universal Slave Driver will revert to the selected sample rate. For example, if you are using the Universal Slave Driver to synchronize to a free-running audio tape machine that is running in Variable Speed Override (VSO) mode (to tune a music track to another key), and Pitch Memory is enabled, you can take your digital audio workstation off-line and still have your audio play back at the VSO'ed pitch. If Pitch Memory is turned off, the pitch will revert to the nominal sampling rate.

If Pitch Memory is disabled and the selected external clock reference is not available, then the Universal Slave Driver will revert to the nominal, selected *internal* sample rate setting.

#### 14. Window Dub

Establishes the parameters of the Universal Slave Driver's window dubbing features.

Clicking *Window Enabled* will overlay a window dub onto an incoming video signal (assuming the Universal Slave Driver is configured correctly for window dubbing, as described in detail later in this chapter). Other parameters include:

- *Size* — Sets the relative size of the window dub . The choices are *Small* or *Large*. The default setting is *Large.*
- *Vertical Position* — Sets the vertical position of the window dub, relative to the bottom of the video picture. The choices range from *10% From Bottom* to *50% From Bottom*, in 10% increments. The default setting is *20% From Bottom.*

*Note: "10% from Bottom" vertical position is outside the standard "safe title" area, which means it may not be visible on some video monitors.*

- *Horizontal Position* — Sets the window dub's relative horizontal position within the video picture. The choices include *Extreme Left*; *Left*; *Center*; *Right*; or *Extreme Right*. The default setting is *Center.*

*Note: The "Extreme" horizontal positions are outside the standard "safe title" area, which means they may not be visible on some video monitors.*

- *Color* — Sets the color of the time code numbers in the window dub, and the color of the window dub's background. The choices include *White on Black Bkgnd*; *Black on White Bkgnd*; *White on Video Bkgnd*; or *Black on Video Bkgnd*. (*Video Bkgnd* means that the window dub's background is transparent, so that the time code numbers are displayed directly on top of the video signal, without a contrasting background "box.") The default setting is *White on Black Bkgnd.*

#### 15. Bi-phase/Tach Parameters

Used for specialized applications that involve film or other equipment that output Bi-phase/Tach information.

The *Input Signals* parameter determines the "direction" of the Bi-phase/Tach signal. With a Bi-phase signal, the relationship of the "A" and "B" square waves describes the direction. With a Tach signal, the "A" signal exclusively supplies clock information; the steady state of the "B" signal (high or low) describes the direction. (More information about Bi-phase/Tach signals is detailed later in this chapter.) The parameter choices include:

- *Bi-phase: FWD = A leads B* — Here, when the A square wave is ahead of the B square wave, the direction of the Bi-phase signal is understood to be "Forward."
- *Bi-phase: FWD = B leads A* — Here, when the B square wave is ahead of the A square wave, the direction of the Bi-phase signal is understood to be "Forward."
- *Tach: FWD = B is Low* — Here, when the B signal is in a "low" state, the direction of the Tach signal is understood to be "Forward."
- *Tach: FWD = B is High* — Here, when the B signal is in a "high" state, the direction of the Tach signal is understood to be "Forward."

The *Pulses Per Frame* parameter is used to set the number of Bi-phase/Tach pulses per frame of time code. You can input the value directly using your computer keyboard, and then set it by clicking *Set PPF*.

#### 16. Generator/Bi-phase Preset

Serves two functions:

1) When the Universal Slave Driver is configured to function as a time code generator (Positional Reference = *Generate*), you can set the time code start time directly by clicking in the *Hrs:Min:Sec:Frm* fields and typing in a value. The Tab key will cycle though the fields. Clicking *Set* will set the main Time Code Window to the start time value. Clicking *Run* will start the generator. Clicking *Stop* will stop the generator. Clicking *Zero* will set all fields to *00:00:00:00*.

2) When the Universal Slave Driver is configured to receive its positional reference from *Bi-phase/Tach*, you can set the time code start time directly by clicking in the *Hrs:Min:Sec:Frm* fields and typing in a value. Clicking *Set* will set the main Time Code Window to the start time value. Clicking *Zero* will set all fields to *00:00:00:00*. In this way, as soon as the Universal Slave Driver detects incoming Bi-phase/Tach information (plus a corresponding clock reference), it will begin to generate a time code address in relation to the pulses of the incoming Bi-phase/Tach information. (Setting a preset start time is necessary because Bi-phase/Tach has no positional information of its own. However, given a preset start time, the Universal Slave Driver can calculate and generate time code based upon the direction of the Bi-phase/Tach pulses).

   For example, you can pause your flatbed film editor at a particular desired start point (such as Academy leader or a specific sync point in the film), and then enter the desired start time for that event in the Generator/Bi-Phase Preset section of the USD Setup (and click *Set*). Once you begin playback on the flatbed film editor, the Universal Slave Driver will output time code with a *positional reference* that corresponds to the start time you have set.

#### 17. Variable Speed Override (VSO)

Used to varispeed the rate of Universal Slave Driver's internal crystal-referenced clock (± 699 cents; a cent is one-hundredth of a semitone). The varispeed rate is available only in Remote Control mode from the host CPU, and when the Positional Reference is set to Generate.

Checking the *VSO Enabled* box enables varispeed. An "X" in this box indicates that varispeeding is enabled. Drag the appropriate horizontal slider to adjust the varispeed value in semitone and cent increments. When you have finished adjusting the varispeed rate, click the *Set* button to enable the changes.

Alternatively, click the mouse in the number field, type in the desired value, and click the *Set* button. Out of range values will be automatically translated into minimum/maximum values (from ± 699 cents).

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## Preparing the USD Setup

It's time to roll up our sleeves, and to learn how to use USD Setup to configure and control the Universal Slave Driver. First, we'll need to get USD Setup ready for use.

### Establishing Connections

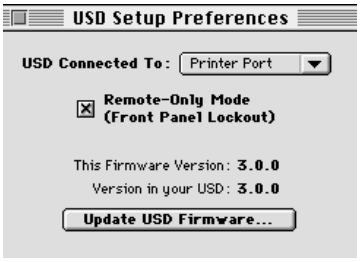
Before you launch USD Setup, ensure that you've connected one of your Macintosh's serial ports to your Universal Slave Driver's Mac Serial port, using the included Mac serial cable. You can use either the printer port or the modem port. If you need to review the procedure for connecting the Universal Slave Driver to your Mac, please refer to Chapter 2 in this User's Guide.

After you've made that connection, you may want to establish the other connections that will apply to your studio and your needs. For instance, if you plan to synchronize Pro Tools to a VTR using VITC, now would be a good time to connect a video signal output from your VTR to the *Video In* connector of the Universal Slave Driver, and to connect the Universal Slave Driver's *Super Clock Out* connector to the *Super Clock In* connector on the back of your Pro Tools audio interface. Similarly, if your studio uses a black burst generator to establish house sync, you may wish to connect a feed from the black burst generator to one of the Universal Slave Driver's video inputs (usually the *Video Ref In* connector).

For more information about connecting your Universal Slave Driver with the rest of your studio, please refer back to Chapter 2. In the coming pages, we'll also detail some of the connections you need to perform certain functions.

## USD Setup Preferences

With the USD Setup application open, select *USD Setup Preferences* under the *Preferences* menu at the top of your screen. The following window will appear:




*The USD Setup Preferences window*

First, select the appropriate serial port for your Universal Slave Driver-to-Macintosh connection (*Modem Port* or *Printer Port*).

### Setting Remote-Only Mode

If you plan to use the USD Setup application as the only means to control your Universal Slave Driver, make sure *Remote-Only Mode (Front Panel Lockout)* is checked (the default setting). This mode ensures that front panel access will be "locked out" when controlling the Universal Slave driver from the USD Setup. For example, if the Universal Slave Driver is installed in a machine room and you wish to eliminate the possibility of someone accessing the Universal Slave Driver while it's in remote use, be sure to check this setting.

With this *Remote-Only Mode (Front Panel Lockout)* selected, none of the Universal Slave Driver's front panel controls will be operational (other than the AC mains power switch), and its front-panel *Remote Mode* LED will illuminate. Furthermore, if you try pressing any of the Universal Slave Driver's front panel controls, its *Remote Mode* LED will flash several times, to remind you that the Universal Slave Driver is configured from remote-only mode, and that its front panel controls are "locked out."

If you deselect the *Remote-Only Mode* option within USD Setup, then you can control the Universal Slave Driver using either its front panel controls or USD Setup. Note that there is bidirectional communication between the Universal Slave Driver front panel controls and USD Setup—so when you change a setting in one place, it will update the other.

### Updating the USD Firmware

The Universal Slave Driver contains a flash EEPROM that allows you to update the firmware in your unit at any time. This means that as Digidesign continues to create improvements for your Universal Slave Driver, you can update your unit in the field without having to send it back to the factory or replace any chips. USD Setup's *Update USD Firmware* feature is used to download up-to-date firmware settings to your Universal Slave Driver.

Note that in the Preferences window just above the *Update USD Firmware* button, the version number of the firmware actually running in the Universal Slave Driver is displayed, along with the version number of USD Setup. This indicates whether an older version of firmware is running or confirms that the running firmware is up-to-date.

*Note: If you purchased your Universal Slave Driver new, then it is already loaded with the firmware settings that are included with your copy of USD Setup. However, these settings may be occasionally updated. To acquire the latest firmware settings, please contact Digidesign Customer Service, or visit the Digidesign Web site at www.digidesign.com.*

***To update your Universal Slave Driver's firmware:***

1. Click on the *Update USD Firmware* button. You'll see the following window:


*The Update USD Firmware window*

2. As instructed, turn off the Universal Slave Driver's AC mains power switch for five seconds.
3. Press and hold down the Universal Slave Driver's front panel *Set* button. Continue to hold it for five seconds after you turn the Universal Slave Driver's power back on, and then release the *Set* button.

*Note: The Universal Slave Driver's LEDs and time code display will not be illuminated during this firmware update procedure.*

4. Click the *Update* button in the USD Setup window. Firmware updating will proceed automatically. After about a minute, the following window will appear:


*The Flash Programming status dialog*

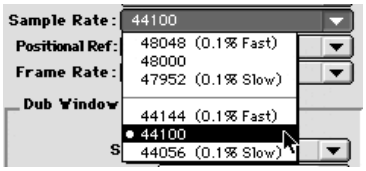
*If for some reason the firmware updating process could not be completed, a dialog will appear instructing you to turn off the Universal Slave Driver and relaunch the USD Setup. Click Quit, relaunch the USD Setup, and start over the firmware updating process.*

5. As instructed, turn the Universal Slave Driver off and back on again, and then click *OK* in the window. You've now completed the firmware updating procedure.

### Selecting Your Sample Rate

Finally, before you proceed, you'll want to set the audio sample rate that you'll be using for your session.

The reason we set this here is that most of what we can perform with the Universal Slave Driver requires us to establish a "nominal" audio sample rate that the Universal Slave Driver will use to make relative adjustments when resolving to a clock reference. More about how the Universal Slave Driver resolves sample rates to clock references will be described in detail in the coming pages. For now, simply choose the appropriate audio sample rate:




*Selecting the Sample Rate*

Note that if you're working with an existing Pro Tools or AudioVision session, you'll want to select the existing sample rate. If you're about to begin work on a new session, you'll be choosing a sample rate that you'll be using for the duration of the session.

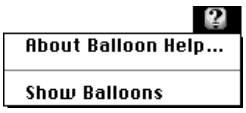
For more information about which sample rate to choose, as well as information about the *Pull Up* and *Pull Down* options, please refer to Chapter 1.

## Using Balloon Help

The USD Setup software provides on-line support using Balloon Help, which can be activated by selecting *Show Balloons* from the Macintosh's *Balloon Help* menu (in the upper-right corner of the Finder). Balloon Help will show you the functions of each on-screen item as you move the mouse across main application window. This help system gives you detailed information about how to use the USD Setup software without having to refer to this User's Guide.

***To activate Balloon Help:***

1. From the Macintosh's *Balloon Help* menu located in the upper-right corner of the Finder, select the *Show Balloons* command. Balloon Help is activated.




*Balloon Help is available in the Balloon Help menu*

***To deactivate Balloon Help:***

1. From the Macintosh's *Balloon Help* menu located in the upper-right corner of the Finder, select the *Hide Balloons* command. Balloon Help is deactivated.

## Resolving to a Clock Reference

As you'll recall from Chapter 1, the Universal Slave Driver needs a clock reference to establish "how fast we're going." The goal is to use the appropriate clock reference for your system, so that everything in your studio is running at the same speed. In this way, the Universal Slave Driver, your VTR, and AudioVision or Pro Tools (or other compatible workstation) will all "agree" on how long a second is, so that they stay synchronized over time.

*Note: Both AudioVision and Pro Tools work with the Universal Slave Driver in similar ways, and both can use all of its features. Consequently, for simplicity's sake, when we refer to just Pro Tools, please keep in mind that the information also applies equally to AudioVision, unless otherwise noted.*

When used with an external clock reference, the Universal Slave Driver is functioning as a *resolver*—so that Pro Tools and other devices can be synchronized, or "resolved," to a common clock source. Let's take a closer look at the nature of resolving Pro Tools to an external clock.

### Resolving Pro Tools to an External Clock

Synchronization implies a clock-referenced relationship between a *master* device and at least one *slave* device. Simply speaking, a synchronizer (such as the Universal Slave Driver) takes clock information from a master (such as a VTR), and uses this information to control a slave (such as Pro Tools). As the master plays at its normal speed, the synchronizer tells the slave to play (or record) at exactly the same speed. As the master speeds up or slows down (by a lot or a little), the synchronizer tells the slave to speed up or slow down.

Some synchronizers (such as the TimeLine Lynx™ series) are "transport" synchronizers, and able to adjust the speed of the slave motors to match the speed of the master. Think of two synchronized audio tape recorders, for example: During playback, small fluctuations in the speed of the master ATR's capstan motor servo are read by the transport synchronizer, which in turn makes small adjustments to the speed of the slave ATR's capstan motor servo. In this way, the synchronizer resolves the slave to the master, establishing and maintaining sync.

These fluctuations (and resulting adjustments) not only affect speed, but they also affect pitch. The relationship between sample rate to both speed and pitch should be clear to anyone who's used a sampler keyboard, or has experimented with sample rate conversions using Sound Designer II or other programs. As the sample rate of a digital audio recording is lowered, say, from 48 kHz to 44.1 kHz, the recording will play back slower and lower-pitched. If the sample rate is raised, the sample will play back faster and higher-pitched.

When it comes to Pro Tools, there is no motor to adjust. So how does the Universal Slave Driver resolve Pro Tools to a master clock source, so that Pro Tools can play back in sync? How does the Universal Slave Driver adjust Pro Tools speed and pitch? It does so by adjusting Pro Tools' sample clock frequency (or sampling rate) to match changes in the speed of the clock reference. And the result is that Pro Tools' speed and pitch resolves to the master's speed and pitch.

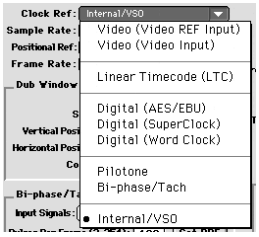
There are limits as to how far Pro Tools sample clock rate (on Pro Tools III/TDM and Project systems) can be varied up and down when resolved to an external clock reference. If Pro Tools is set to either 44.1 or 48 kHz sample rate, then the minimum playback rate is 35 kHz, and the maximum playback rate is 50 kHz.

## Selecting the Clock Source

As we've just learned, the Universal Slave Driver allows Pro Tools to resolve to external clock references. It does so by varying Pro Tools' sample clock frequency to match changes in the clock reference: As the clock reference speeds up, Pro Tools' sample rate is increased; as the clock reference slows down, Pro Tools' sample rate is decreased.

***To choose a clock reference:***

1. Click on the *Clock Ref* pop-up menu and make your selection:




*Selecting the Clock Reference*

And how do you know which clock reference to use? That depends upon the circumstances. Let's examine the options.

### Video (Video Reference Input)

As we've described previously, many post-production facilities use black burst generators to establish house sync, so that all equipment within the facility runs at the same speed. If you want the Universal Slave Driver to clock to house sync, set its clock reference to *Video (Video Ref Input)*. Also be sure to connect a feed from your black burst generator to your Universal Slave Driver's *Video Ref In* connector.

*Note: Remember, a black burst signal is essentially a "position-less" video signal. As with any "shared" video signal, you'll want to ensure that your video feed comes from a properly buffered and distributed source, such as a video distribution amplifier, or the video reference/black burst output of another device in the house sync chain.*

Once configured, you'll probably want to use this clock reference for most situations, especially those where you're synchronizing Pro Tools to an external VTR. (Of course, the VTR should also be receiving its clock reference from house sync.) However, there may be circumstances when you wish to change this setting, especially when you are transferring audio from one device to another (such as from an analog tape recorder or a DAT recorder to Pro Tools), as described in the coming pages.

### Video (Video Input)

Since they're so similarly named, you may wonder what the difference is between using the *Video Ref In* and the *Video In* as your clock reference. Fortunately, in most settings, the difference is clear:

- If you wish to resolve the Universal Slave Driver to house sync, you should select *Video Ref In* as the clock reference, and connect a black burst generator's output to the Universal Slave Driver's *Video Ref In* connector. In most situations, this holds true even if you are synchronizing Pro Tools to a VTR and using VITC for positional information (assuming the VTR is also referenced to house sync).
- If you wish to resolve the Universal Slave Driver directly to an incoming video signal from a VTR or other video source, you should select *Video In* as the clock reference, and connect the video signal to the Universal Slave Driver's *Video In* connector.

There are several reasons why you would resolve the Universal Slave Driver to a video signal rather than a house sync. The most obvious is if you are synchronizing Pro Tools (or other device) to video, and do not have a black burst generator.

Few project studios have a black burst generator, but as long as the video signal is the clock source, then proper sync can be easily achieved. However, house sync becomes especially important when you have multiple devices that may not be synchronized directly but need to run at the same speed. In a smaller synchronized setting with one or two VTRs, Pro Tools and the Universal Slave Driver, using the video signal as the clock reference is often satisfactory.

Another reason to resolve to a video signal rather than house sync is if you are synchronizing Pro Tools to a VTR (or inexpensive PC-based video editing system) that does not have a black burst input for referencing to house sync. For instance, you may be synchronizing to a consumer-grade VCR. In this case, even if your facility has house sync, you would want to sync instead to the VCR's video signal. Similarly, even if you are just transferring audio from a consumer-grade VCR (or inexpensive PC-based editing system) that does not have a black burst input, you should use the video signal as the clock reference.

Finally, you'll note that there is no choice of *VITC* for clock reference. This is because VITC itself does not provide clock information directly as part of its time code information, only positional information. However, since VITC is always embedded into a video signal, that video signal can be used as a clock reference. Consequently, if you wish to sync Pro Tools to a video tape that has only VITC information, then most likely you'll want to select *Video Input* as the clock reference (or *Video Ref In* if your facility has house sync, and the VTR playing back the VITC information is also referenced to house sync).

### Linear Time Code (LTC) • (Clock Reference)

***To resolve the Universal Slave Driver to Linear Time Code:***

1. Select *Linear Time Code (LTC)* under USD Setup's *Clock Ref* pop-up menu.

Also ensure that you've already connected an LTC source to your Universal Slave Driver's *LTC In* connector.

Unlike VITC, LTC provides both positional and clock information as part of the time code signal. LTC is the only type of time code that can be recorded on an analog audio tape track as an audible audio signal. Consequently, if you wish to slave Pro Tools to a "free-running" analog ATR master that is not referenced to a video signal, then LTC is the way to go. In this situation, you would choose LTC for both the clock reference and positional reference.

LTC can also be recorded onto and played back from one of a VTR's audio tracks. (Many professional VTRs have a dedicated audio track, intended for LTC, called an address or "cue" track.) Sometimes audio post-production engineers receive video work tapes that have been striped only with LTC, and not with VITC.

If you are working with house sync in your facility, and you are using LTC as a positional reference, you should *always* choose *Video Ref Input* as the clock reference, since it is a stable and reliable source of sync and will not be prone to dropouts.

Keep in mind that LTC cannot be read when the reference deck is stopped or playing back at slow speeds. This is because the LTC signal cannot be detected when the source is stopped, or is at too low a pitch (when playing slowly). Similarly, at fast wind speeds, the pitch of the LTC may rise beyond the upper playback frequency response of the reference deck (typically 10x or more playback speed), preventing the Universal Slave Driver from being able to read the LTC. We'll discuss more about reading LTC—and when to use VITC instead of LTC—later in this chapter.

#### Linear *Temperamental* Code?

Because it's an analog audio signal, LTC can sometimes be troublesome. The problems are almost always related to either tape drop outs (tape shedding), or to level mismatches between the LTC source and the LTC input. As we described earlier in this chapter, the Universal Slave Driver's freewheeling feature allows you to compensate for brief time code drop outs. However, if you have serious drop outs, you may not be able to sustain accurate synchronization.

As far as level mismatches go, one thing to ensure is that the LTC is recorded (on the master device) at proper levels—not so high as to be distorted or to cause crosstalk problems on an adjacent audio track, and not so low as to be prone to drop outs or noise interference. After that, you'll want to ensure that the LTC output level is calibrated to match the Universal Slave Driver's LTC input levels. Fortunately, the Universal Slave Driver supports a wide range of LTC input levels (from –24 dBu to +20 dBu), so this shouldn't be a problem.

It is good practice on a 24-track analog tape machine to record time code on Track 24 at a reference level of -10 dBu (or lower), with Track 23 left blank as a "guard" track. This practice avoids crosstalk "bleed" that can occur between the time code track and otherwise adjacent audio tracks. Time code (which is a mid-frequency alternating pitch square wave) is very sensitive to crosstalk from adjacent tracks, and conversely you don't want audible time code leaking onto your audio tracks. In addition, to avoid problems when recording time code on analog tape machines, the machine should be "free-running." That is, it should be under control of its own internal crystal. If you have transport synchronizers connected to your machine, you should ensure that they are *not* controlling it when recording time code.

### Digital (AES/EBU); Digital (Word Clock); Digital (Super Clock)

A reference clock signal is part of any digital recording system. It is required because whenever digital audio information is mixed together or passed between devices, the playback samples must be aligned with the recording samples. In some cases (such as with AES/EBU or S/PDIF digital interfaces), the clock signal is imbedded in the data stream itself. In other cases, the clock signal is carried as an entirely separate signal from the digital audio sample data.

The Universal Slave Driver is able to resolve to three different types of digital audio clock information: AES/EBU, Word Clock, and Super Clock (256x Slave Clock). If the Universal Slave Driver is part of your Pro Tools system, and you need to transfer digital audio from an external device to Pro Tools, you'll probably want to resolve your Universal Slave Driver to one of these three digital audio clock types.



#### AES/EBU

The AES/EBU audio data stream contains clock information as part of its signal. For instance, when you connect the AES/EBU output of a DAT machine to the AES/EBU input of a Digidesign 888 I/O or 882 I/O Audio Interface and then set Pro Tools to *Digital* sync mode (in Pro Tools' Session Setup window), Pro Tools will resolve automatically to the DAT machine. (This can be done without using the Universal Slave Driver.)

Some professional digital audio products use AES/EBU "null clock" (which is an AES/EBU data stream that contains only clock information only and no audio information) as a *system clock reference* source. These systems would then rely upon a single AES/EBU master clock source that is distributed throughout a digital audio facility, in much the same way that house sync is distributed throughout a video facility. If you are connecting the Universal Slave Driver to such a system, you will want to use the Universal Slave Driver's AES/EBU input as the clock reference connection, so that all system components are referenced to the same time base.

In some cases (such as using the Universal Slave Driver as a stand-alone clock resolver or time code generator without a digital audio workstation), you may wish to use an audio DAT machine (or other similar device) as a source of AES/EBU null clock, and resolve your system to this reference source. In this case, the audio sample data in the AES/EBU data stream is stripped off, and only the clock information is used.

***To resolve the Universal Slave Driver to an external AES/EBU reference clock signal:***

1. Connect your AES/EBU null clock reference signal to the Universal Slave Driver's *AES In* connector.
2. Select *Digital (AES/EBU)* under USD Setup's *Clock Ref* pop-up menu.

*Note: If the chosen clock reference source is unavailable, or the current configuration is not valid, the Locked LED on the far-right of the Universal Slave Driver front panel will flash off-and-on.*

If you are using AudioVision or Pro Tools, be sure to connect the Universal Slave Driver's *Super Clock Out* connector to the *Super Clock In* (or *Slave Clock In*) connector of your 888 I/O or 882 I/O (or other audio interface). The Universal Slave Driver will convert the AES/EBU clock signal to the more precise Super Clock standard used by all Digidesign audio interfaces.

*Note: The Universal Slave Driver's AES In connector only recognizes and uses the clock portion of an incoming AES/EBU audio signal. This is also called "AES digital black," "silent audio" or "null clock" information. Although you can connect a complete AES/EBU audio signal to the Universal Slave Driver, all audio information will be stripped off. Furthermore, audio information will not be passed to the Universal Slave Driver's AES Out connector.*

### Word Clock (1x)

Word Clock is a digital clock reference signal that runs at *1x* sample rate, which is the same rate as the clock signal carried within an AES/EBU or S/PDIF data stream. However, devices that support Word Clock have separate, dedicated BNC-style Word Clock connectors—which carry no audio information of their own. A wide variety of professional audio devices have such Word Clock connectors, including some digital mixing consoles, DASH-standard digital multitrack tape recorders, and Tascam DA-88-compatible 8-track modular, digital multitrack decks.

You should resolve the Universal Slave Driver to Word Clock any time you are transferring digital audio from one of these devices to Pro Tools (assuming the device doesn't have a Super Clock connector).

***To resolve the Universal Slave Driver to the device's Word Clock:***

1. Connect your 1x word clock reference signal to the Universal Slave Driver's *Word Clock In* BNC connector.
2. Select *Digital (Word Clock)* under USD Setup's *Clock Ref* pop-up menu.
3. If the AES/EBU reference clock source is *not* valid for any reason (such as a poor connection, or other signal transmission problem), the *Locked* LED (on the USD front panel's far right) will flash on and off.

If you are using Audio Vision or Pro Tools, be sure you have the Universal Slave Driver's *Super Clock Out* connected to your Digidesign audio interface's *Super Clock In* (or *Slave Clock In*). The Universal Slave Driver will convert the Word Clock signal to the more precise Super Clock standard used by all Digidesign digital audio interfaces.

### Super Clock (256x)

Super Clock (or Slave Clock) is Digidesign's proprietary hi-speed Word Clock which runs at 256x the sample rate. All Digidesign audio interfaces, and several other Digidesign products (including the ADAT Interface, the SMPTE Slave Driver, and the Video Slave Driver), are equipped with Super Clock inputs and outputs.

Super Clock is conceptually the same as Word Clock, in that it's a clock signal that can be passed between devices independently of the audio signal. However, since it runs at 256x sample rate (instead of Word Clock's 1x sample rate), Super Clock is inherently more precise than Word Clock and thus less susceptible to clock signal jitter.

You should resolve the Universal Slave Driver to Super Clock any time you are transferring digital audio from one Digidesign workstation to another, or for those specialized circumstances when you want to resolve the Universal Slave Driver to a SMPTE Slave Driver or Video Slave Driver.

***To resolve the Universal Slave Driver to Super Clock:***

1. Connect your 256x Super Clock (Slave Clock) source signal to the Universal Slave Driver's *Super Clock In* BNC connector.
2. Select *Digital (Super Clock)* under USD Setup's *Clock Ref* pop-up menu.

*Note: If the Super Clock source is not valid for any reason (such as a poor connection or other signal transmission problem), the Locked LED on the far-right of the Universal Slave Driver front panel will flash on and off.*

Also, be sure you have the Universal Slave Driver's *Super Clock Out* connected to your "slave" Digidesign audio interface's *Super Clock In* (or *Slave Clock In*).

### Pilot Tone

The Universal Slave Driver can resolve to an external Pilot Tone signal. This is a relatively specialized application, used by audio post-production engineers for synchronizing to (or transferring audio from) certain types of open-reel audio tape recorders. In general, Pilot Tone is a sine wave reference signal running at the "line frequency" or "mains frequency," meaning the same frequency transmitted by the AC line voltage from the local power utility.

Pilot tone is used on location film shoots to establish a common sync reference between a film or video camera with a portable 1/4" analog ATR (such as those made by Nagra or Stellavox). On location, Pilot Tone is derived by clock-referencing the camera to the local AC line frequency (which is 60Hz or 50Hz depending on the country of origin), and this same frequency is then used to clock-reference the ATR. The result is that both the camera and the ATR will run at the same speed.

You can think of Pilot Tone as a kind of inexpensive and readily available "house sync" for location production. Increasingly, it's being replaced by time code, since new-generation film cameras as well as many portable DAT recorders are time code-capable. However, Pilot Tone is still used by a large number of production companies and location sound recordists, which is why the Universal Slave Driver features the ability to use Pilot Tone as a clock reference.

Please note that Pilot Tone contains no *positional* information; it is simply a clock reference. Consequently, sometimes you may encounter an analog 1/4" audio tape that was clock-referenced to Pilot Tone, but which also contains a track of LTC time code. In such situations, you should use the Pilot Tone as the clock reference, and the LTC as a positional reference (especially if the LTC suffers from dropouts).

***To resolve the Universal Slave Driver to Pilot Tone:***

1. Connect your Pilot Tone reference source to the Universal Slave Driver's *Bi-Phase/Tach/GPI/Pilot* port. For detailed wiring information, please see Appendix I.

2. Select *Pilot Tone* under the USD Setup's *Clock Ref* pop-up menu.

*Note: If the Pilot Tone reference source is not valid for any reason (such as a poor connection or other signal transmission problem), the Locked LED on the far-right of the Universal Slave Driver front panel will flash on and off.*

## Bi-phase/Tach

The Universal Slave Driver is able to resolve to Bi-phase/Tach information for use as a clock reference. As with LTC, Bi-phase/Tach can also be used to provide a positional reference if you provide a reference "start address" via the USD Setup application. (Unlike LTC, the Universal Slave Driver has to interpolate positional information from a Bi-phase/Tach, as described later in this chapter). As with Pilot Tone, resolving to Bi-phase/Tach is a relatively specialized application. It is typically reserved for working with mag machines; 16mm, 35mm and 70mm projectors; flatbed editing systems; and certain other types of motor-driven film equipment.

Bi-phase (sometimes called "Quadrature Sync") and Tach information are similar—which is why we generally lump them together in this manual—though they do differ. A Bi-phase signal consists of two square pulse waves, which are generated directly by a device's transport mechanism, and which are 90° out-of-phase with one another. As a Bi-phase-generating device plays, it outputs a steady stream of square wave pulses, which the Universal Slave Driver can use as its clock reference. The Universal Slave Driver can resolve to Bi-phase/Tach information at nearly any speed (including still/paused).

The Universal Slave Driver uses the phase relationship between the two square waves to determine the device's direction (forward or reverse). However, this is relevant only when the Universal Slave Driver is using the Bi-phase signal as a positional reference (as described later in this chapter.)

A Tach signal is a variation of Bi-phase. With Tach's two signals, one is used only as the direction indicator, while the other is used as the velocity, or "rate," indicator—which the Universal Slave Driver uses when resolving to Tach as a clock reference. (The differences between Bi-phase and Tach are discussed in greater detail later in this chapter.)

There are several different standards for the number of pulses-per-frame outputted by Bi-phase or Tach devices. Using USD Setup's *Pulse Per Frame* setting, you can set the Universal Slave Driver to operate from 2 to 254 pulses per frame. (The setting should match the PPF rate of the external device's Bi-phase/Tach encoder.)

***To resolve the Universal Slave Driver to Bi-phase/Tach:***

1. Connect your reference device's Bi-phase/Tach signal to the Universal Slave Driver's *Bi-phase/Tach/GPI/Pilot* connector, ensuring that the cable is wired appropriately, as described in Appendix I. Also, if you wish to use the Universal Slave Driver to resolve Pro Tools to the Bi-phase/Tach clock reference, be sure the Universal Slave Driver's *Super Clock Out* is connected to your Digidesign audio interface's *Super Clock In* (or *Slave Clock In*) connector.

2. Select *Bi-phase/Tach* under USD Setup's *Clock Ref* pop-up menu.

3. Select the appropriate Pulse Per Frame and the Input Signals parameters, as described earlier in this chapter.

*Note: If the Bi-Phase/Tach reference clock source is not valid for any reason (such as a poor connection or other signal transmission problem), the Locked LED on the far-right of the Universal Slave Driver front panel will flash on and off.*

### Internal

In some cases you won't be resolving the Universal Slave Driver to an external clock reference. Rather, you'll be resolving the Universal Slave Driver to its own, crystal-referenced internal clock. In this situation, the Universal Slave Driver will be defining for Pro Tools (and anything else that's receiving its clock reference from the Universal Slave Driver) "how fast we're going."

There are several situations in which you should resolve the Universal Slave Driver to its internal clock, including when you wish to use the Universal Slave Driver as:

- a freestanding time code generator (where clock information and positional information are generated directly by the Universal Slave Driver);
- a time code regenerator (where the external positional reference may be accurate, but the external clock reference may not be); or
- a system (or studio) "master clock" (where you may not have access to a black burst generator, or video reference signal, or other such source).

***To resolve the Universal Slave Driver to its internal clock:***

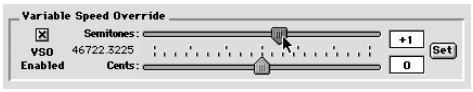
1. Select *Internal/VSO* under USD Setup's *Clock Ref* pop-up menu.

### Variable Speed Override (VSO)

You can also varispeed the rate of the Universal Slave Driver's crystal-referenced internal clock. This capability allows you to literally "fine-tune" the speed and subsequent pitch of Pro Tools and any device receiving its clock reference from the Universal Slave Driver. The Universal Slave Driver's internal clock can be varied to raise or lower the pitch of program material by ± 699 cents (± 6 semitones).

***To varispeed the rate of the Universal Slave Driver's internal clock:***

1. In the USD Setup's Variable Speed Override section, check the *VSO Enabled* box. An "X" indicates that varispeeding is enabled.




*The Variable Speed Override section*

2. Adjust the varispeed value in semitone or cent increments by dragging the appropriate horizontal sliders. The actual output word-clock frequency is shown in between and to the left of the sliders. If the varispeed value exceeds the limits of frequency available (35 KHz on the low end and 50 KHz on the high end), then the frequency display is pegged at the extreme limit and displayed in red.
3. When have finished adjusting the varispeed rate, click the *Set* button to enable the changes.
4. Alternatively, click the mouse in the number field, type in the desired value, and then click the *Set* button. Out of range values will be translated into minimum/maximum values (± 6 semitones; ± 99 cents).

## Using Pitch Memory

When selected, the Universal Slave Driver will remain at the last known "pitch" (i.e. incoming clock reference speed), even when the tape is stopped. For instance, if LTC from an audio tape recorder (ATR) is used as a clock and positional source, and the ATR is being "varispeeded" fast or slow, Pro Tools' sample rate will adjust to match the ATR's pitch. This can be used, for instance, to resolve the Universal Slave Driver to "off-speed" free-running LTC.

If Pitch Memory is enabled, and you continue playing back audio in your Pro Tools session after the incoming clock reference has stopped, then Pro Tools will continue to stay "in tune" with the rest of the tracks. In most situations, this is how most people will prefer to work.

If Pitch Memory is disabled and the selected external clock reference is not available, then the Universal Slave Driver will revert to the nominal, selected *internal* sample rate setting.

## Working with Positional References

As you'll recall from Chapter 1, the Universal Slave Driver needs a positional reference to establish the trigger point for playback, or "where we are." This reference always goes hand-in-hand with a clock reference, which establishes "how fast we're going."

(Technically speaking, the Universal Slave Driver's clock resolving and time code reading/generating capabilities are independent. However, from a user's point of view, a clock reference is necessary whenever working with time code—although a positional reference is not necessary for clock resolving.)

Establishing the Universal Slave Driver's positional reference can be an easier decision than establishing the clock reference. This is because it's usually clear what source you'll want to use as a positional reference. For instance, to slave Pro Tools to a video tape, you'll need the video tape's time code (LTC, VITC, or both) as the positional source. At the same time, the choice of clock source might be less obvious, since (depending upon your studio and needs) you might have your choice of house sync (Video Ref), video signal (Video), LTC, or more.

*Note: For most users, time code (LTC or VITC) is the only positional reference they'll ever use. This applies whether the time code is from an external source, or whether it's generated internally by the Universal Slave Driver. Since, however, the Universal Slave Driver can "deduce" a positional reference based on an incoming Bi-phase/Tach signal, "time code" and "positional reference" are not always directly synonymous. Even so, we'll usually treat these two terms as interchangeable, unless we are referring specifically to Bi-phase/Tach.*

### About Time Code & DAWs: Positional Reference (Trigger Start Point) + Clock Reference = Sync

You can resolve the Universal Slave Driver to an external clock reference without locking it a positional reference. For instance, you can use the Universal Slave Driver to resolve Pro Tools' clock to house sync, without synchronizing Pro Tools to external time code.

However, whenever you lock the Universal Slave Driver to a positional reference, you'll need resolve it to a clock reference (even if you use the Universal Slave Driver's internal clock). This is because Pro Tools (as well as all digital audio workstations) requires a clock reference—in addition to time code—in order to maintain synchronization over time.

Let's explore this a little further using a typical sync situation, with Pro Tools being slaved, via a Universal Slave Driver, to a video tape recorder:

1. When you start the videotape, time code (it could be either LTC or VITC in this example) is read off the tape and is routed to the Universal Slave Driver.
2. Next, via a MIDI interface, the Universal Slave Driver sends Pro Tools the address of the first instance of time code it receives. (An upcoming release of Pro Tools software will be able to receive Universal Driver information without a MIDI interface.) At the same time, based upon whatever clock reference you've chosen, the Universal Slave Driver sends Super Clock information to Pro Tools. (With just a simple system, without house sync, you would probably use *Video In* as the Universal Slave Driver's clock reference.)
3. In turn, Pro Tools takes the first time code address it receives, and calculates the point (sample number) in the session that corresponds to the address. (Even though you can work with Pro Tools using any standard time code format, it actually "thinks" in terms of sample numbers—which means that it translates the time code address to an exact sample number).
4. Assuming that the time code address corresponds to a sample number that is within the Pro Tools session, Pro Tools uses that address to start playback at the "trigger point." That is, it converts the time code address to a sample number within the session, and begins playing back from that point.
5. Once playback has been initiated, Pro Tools now turns to the Universal Slave Driver's clock reference (sent as Super Clock to Pro Tools). This clock reference now "drives" Pro Tools playback, so that if the videotape were to undergo minor speed deviations during playback, Pro Tools would stay perfectly synchronized.
6. At this point, if the videotape is stopped, rewound, and started again, the entire process is repeated, based upon a newly calculated trigger point.

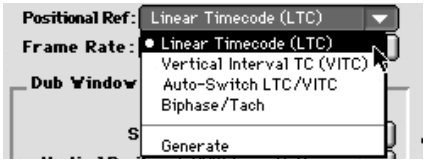
In this way, Pro Tools uses both time code (positional) and clock references to maintain synchronization—and the Universal Slave Driver delivers both.

## Selecting the Positional Source

The Universal Slave Driver uses positional information to send Pro Tools a "trigger start" time code address, and then sends Super Clock information to Pro Tools to maintain synchronization.

***To choose your positional reference:***

1. Click on the *Positional Ref* pop-up menu and make your selection:




*Selecting the Positional Reference*

*Note: Be sure to select the appropriate frame rates whenever you use LTC or VITC as your positional reference!*

Let's review the positional reference options in detail.

### Linear Time Code (LTC) • (Positional Reference)

As described earlier, since LTC is recorded and played back as an analog audio signal, LTC can be striped onto any ATR's or VTR's audio track. (Professional VTRs typically have an address or "cue" track, intended for LTC.) As also described, if you are working with a standard audio tape, you'll almost certainly be working with LTC; if you're working with a videotape, you may be able to work with either LTC or VITC, or both.

LTC can function simultaneously as a *positional* reference and a *clock* reference. As a positional reference, LTC has several benefits and drawbacks when compared to VITC:

- LTC is usually striped before the music and other audio tracks (on an ATR), or at the same time as the video signal (on a VTR). If necessary, LTC can be striped independently of other audio tracks or the video picture. This can be helpful if the time code needs to be rerecorded over the existing LTC track or, in the case of a multitrack tape machine, on another track.
- LTC can be read at faster winding rates than VITC (up until the LTC's pitch exceeds the upper high-end frequency response of the ATR or VTR).
- Unlike VITC, LTC cannot be read when the deck is paused or "crawling" slowly. When working with Pro Tools, this means that LTC cannot be used for Auto-Spotting regions when jogging the videotape to particular video frames.
- Use of LTC is universal throughout the audio post-production community. The use of VITC is not as common in the audio community, although it is more common in video editing applications. Many audio professionals using DAWs are not aware of the benefits of working with VITC, especially for still-frame spotting. In addition, VITC must be recorded at the same time as the video signal, and cannot be dubbed on later (unless a copy of the original video element is made). As a result, you may find it is more difficult to get work prints containing VITC from post-production houses. However, the benefits of using both forms of time code are clear, and it's well worth trying to get elements that contain both standards for maximum flexibility and speed when working.
- LTC can be more prone than VITC to tape-shedding problems and subsequent time code dropouts. (This is why the Universal Slave Driver offers a freewheeling feature, as detailed earlier in this chapter.)

***To use LTC as the Universal Slave Driver's positional reference:***

1. Select *Linear Time Code (LTC)* under USD Setup's *Positional Ref* pop-up menu.

Ensure that you've selected the appropriate clock reference, sample rate, frame rate, and freewheel duration. Also ensure that your LTC signal is routed properly to the Universal Slave Driver's *LTC In* connector.

### Vertical Interval Time Code (VITC)

VITC is a commonly used positional reference in professional audio post-production. Since VITC is time code information that is embedded as part of the video signal, you can obtain a time code reading whenever you can see a video picture. This offers several benefits:

- VITC can be read when the VTR is paused or crawling slowly. When working with Pro Tools, this means that VITC can be used for Auto-Spotting regions to particular video frames.
- VITC is less prone to tape drop outs, and in this sense, is inherently more reliable than LTC.

- VITC can be embedded into any video signal, including digital video signals (tape or nonlinear), without requiring an extra audio track to carry time code.

*Note: In order for VITC to be read when a videotape is paused, the picture must remain visible. However, to save wear-and-tear on video heads, after a few minutes of still/pause mode, many VTRs will automatically drop into stop mode—which means the tape will be disengaged from the video heads, and VITC can no longer be read off the tape. To continue reading VITC, you may need to reengage still/pause, or press play and re-shuttle the tape to the desired frame.*

*This problem highlights a reason for using Video Ref In as your clock reference instead of Video In, whenever possible. Even when the video picture disappears, the Universal Slave Driver will remain resolved to the black burst signal at the Video Ref In connector, this ensuring a constant supply of resolved Super Clock information to your Pro Tools system (or other compatible DAW).*

***To use VITC as the Universal Slave Driver's positional reference:***

1. Select *Vertical Interval Time Code (VITC)* under USD Setup's *Positional Ref* pop-up menu.

Ensure that you've selected the appropriate clock reference, sample rate, frame rate, and freewheel duration. Also ensure that your VITC-striped video signal is routed properly to the Universal Slave Driver's *Video In* connector (not the *Video Ref In* connector). If you wish to use a black burst signal as the clock reference (instead of the video signal), then be sure to connect it to the *Video Ref In* connector.

### Auto-Switch LTC/VITC

If you wish, you can configure the Universal Slave Driver to switch automatically between LTC and VITC, depending upon which is delivering the best signal at any given time. This is a very flexible configuration, and is the USD's default setup mode when powered on (unless changed).

For instance, as we've described, when a VTR is paused, it's impossible to read LTC off a paused videotape. Consequently, using only LTC, there's no way you can use Pro Tools to perform Auto-Spotting of regions when the tape is paused. However, VITC continues to be read whenever the picture remains visible), so it can be used as a positional reference when the VTR is paused. On the other hand, VITC cannot be read at fast winding speeds (except by some specialized, high-end VTRs); LTC can be read at fast winding speeds, as long as its signal remains within the high-end frequency response of the ATR or VTR.

With its auto-switching option, the Universal Slave Driver follows these rules for deciding which time code to read:

- If only LTC is currently readable (for example, if the tape speed is too high to read VITC, or if VITC is not connected), then the Universal Slave Driver will switch to LTC as its positional reference.
- If only VITC is currently available (for example, if the tape is paused, and therefore the videotape deck cannot output LTC, or LTC is not connected), then the Universal Slave Driver will switch to VITC as its positional reference.
- If *both* LTC and VITC are available, the Universal Slave Driver chooses which one to use based on the speed of playback. The switch-over point is approximately 75% of full 1x playback speed. Above 75% playback speed, LTC is favored; below 75% speed, VITC is favored.

- If a dropout should occur, the Universal Slave Driver waits until the freewheel duration has expired before attempting to switch over to the opposite source. If, at that time, neither source is available, the Universal Slave Driver will stop reading time code.

***To have the Universal Slave Driver switch automatically between LTC and VITC as its positional reference:***

1. Select *Auto-Switch LTC/VITC* under USD Setup's *Positional Ref* pop-up menu.

Ensure that you've selected the appropriate clock reference, sample rate, frame rate, and freewheel duration. Also ensure that:

- your LTC signal is routed properly to the Universal Slave Driver's *LTC In* connector;
- your VITC-striped video signal is routed properly to the Universal Slave Driver's *Video In* connector (not the *Video Ref In* connector);
- both your LTC and VITC (and your on-screen video "window burn," if any) have been striped with identical time code numbers; and
- you have selected *Auto* or the correct line pair for VITC Read.

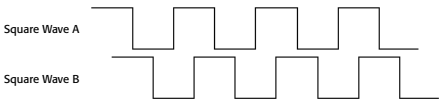
*Note: Some brands of older 3/4" U-matic VTRs have time code address tracks which have a fixed offset of several frames when compared with the audio tracks (which exactly match the video in terms of time). This could cause problems when using your Universal Slave Driver's LTC/VITC auto-switching capabilities. You can verify proper synchronization between your time code and address tracks by comparing the Universal Slave Driver's time code reader numbers, when "looking" at the various tracks, to an on-screen "window burn," on the video work print supplied by the post-production house. Alternatively, you can create your own window burn if you create a dub copy with the Universal Slave Driver, using its time code generation (LTC or VITC) and window burn generation capabilities.*

## Bi-phase/Tach

In most cases, post-production professionals working with film will want to utilize the Universal Slave Driver's ability to lock to a Bi-phase/Tach signal as a positional reference. If you use a mag recorder or other similar film transport, then using a Bi-phase/Tach signal may provide the best (or only) way to slave Pro Tools to the reference.

Strictly speaking, Bi-phase/Tach signals are clock reference signals, and do not contain positional information of their own. However, they do contain enough information for the Universal Slave Driver to calculate positional information. Here's how this works:

Bi-phase/Tach signals use two square waves to generate pulses that can function as a clock reference. The two square waves are 90° out-of-phase, in a pattern that resembles this:




With a Bi-phase signal, the Universal Slave Driver can deduce the direction (forward or reverse) of the signal based upon which wave is read "high" relative to the other. For instance, with some film equipment, when the device is running forward, it will generate a Bi-phase signal where the "A" wave leads the "B" wave—that is, where the A wave peaks before the B wave peaks. When the device is in reverse, the B wave will lead the A wave.

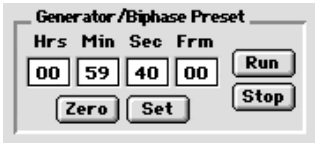
However, some film equipment works in the opposite manner, which is why the Universal Slave Driver's *Input Signals* option lets you make the appropriate selection (*Fwd = A leads B*, or *Fwd = B leads A*).

Calculating the direction of a Tach signal is slightly different. As you may recall, Tach also uses two signals. The "A" signal is a square wave that provides clock information; the "B" signal is in a steady state (high or low) that indicates the direction. Unfortunately, not all Tach-generating equipment uses the B signal in the same way. Fortunately, the Universal Slave Driver's *Input Signals* options allows you to choose the appropriate method (*Tach: Fwd = B is Low*, or *Tach: Fwd = B is High*).

Now you can understand how the Universal Slave Driver can use a Bi-phase/Tach signal to deduce the direction, and how it also uses the signal as a clock reference. However, in order to use the signal as a positional reference, the Universal Slave Driver also needs to know time code address of the starting frame of the first clock signal. Since the Bi-phase/Tach doesn't contain this information, we need to "tell" the Universal Slave Driver what the starting frame is.

***To select the starting frame for a Bi-phase/Tach signal:***

1. In the Generator/Bi-phase Preset section, type in the time code value of the starting frame, in hours:minutes:seconds:frames. (Use your mouse or the Tab key to toggle between the fields.)



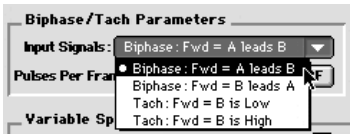

*Setting the Generator/Bi-phase Preset*

2. When you have inputted the proper starting frame, click *Set*.

At this point, the Universal Slave Driver knows two vital things about the Bi-phase/Tach signal: its direction, and its starting frame. Given these two things, the Universal Slave Driver can interpolate and accurately calculate location, just as if the Bi-phase/Tach signal were time code.

***To use Bi-phase/Tach as the Universal Slave Driver's positional reference:***

1. Select *Bi-phase/Tach* under USD Setup's *Positional Ref* pop-up menu.
2. Set the starting frame, as described above.
3. Set the Input Signals option, as appropriate:




*Selecting Bi-phase/Tach input signals*

Occasionally, when you use Bi-phase/Tach as the positional reference, you'll also be using it as the clock reference, so be sure to follow all the appropriate steps as described earlier.

Finally, ensure that the Bi-phase/Tach signal is routed to the Universal Slave Driver's *Bi-phase/Tach/GPI/Pilot Tone* connector, and is wired properly, as described in Appendix I.

## Generate

In this mode, the Universal Slave Driver generates its own positional reference. This feature is detailed in the next section.

## Generating & Regenerating Time Code & Clock Information

The Universal Slave Driver outputs time code and clock information in one of two modes: *Read/Regeneration Mode* and *Generator Preset Mode*. In either mode, the Universal Slave Driver simultaneously regenerates or generates time code (LTC, MTC, and if a video signal is present, VITC), plus a variety of clocks (Super Clock, Word Clock, AES/EBU).

Let's take a closer look at these two modes.

### Read/Regeneration Mode

In this mode, the Universal Slave Driver regenerates time code based upon external positional reference information (LTC or VITC time code, or a Bi-phase/Tach signal). Subject to certain conditions, three types of time code (LTC, VITC, and MTC) are simultaneously regenerated from the selected positional reference.

In order for the Universal Slave Driver to regenerate LTC, the external positional reference must be moving at normal, 1x forward speed (± 10%). In order to regenerate VITC, the positional reference must be LTC or Bi-phase/Tach, at any readable speed, forward or reverse.

*Note: The Universal Slave Driver can regenerate VITC only when the external positional reference is LTC or Bi-phase/Tach (or the positional reference is set Generate). The Universal Slave Driver will not regenerate VITC if the positional reference is VITC.*

In order for the Universal Slave Driver to regenerate continuous MTC, the external positional reference must be moving at normal, 1x forward speed (± 10%). Outside of this speed range and direction, MTC is generated in bursts every 200 milliseconds; this is done to allow MTC-slaved devices to read VITC or Bi-phase properly in either direction, and at any readable velocity down to zero. In any case, the Universal Slave Driver begins regenerating MTC as soon as it detects a valid signal from its incoming positional reference.

If the positional reference is LTC or VITC, the Universal Slave Driver will regenerate time code addresses that are identical to the incoming time code addresses (with a freewheel feature that allows for up to 40 frames of LTC or VITC to be dropped). If the positional reference is a Bi-phase/Tach signal, the Universal Slave Driver will generate time code addresses starting at the Bi-phase preset start time, as described earlier.

### Generator Preset Mode (Positional Reference = *Generate*)

In this mode, the Universal Slave Driver generates time code internally, with a start time is based upon the Generator Preset Time (as detailed earlier in this chapter). Using either USD Setup or the Universal Slave Driver's front panel controls, you can start, stop, resume, and reset time code generation.

When generating time code in Generator Preset Mode, the Universal Slave Driver's time code generator is resolved (locked) to one of two possible sources, based upon the following rule:

#### Generator Reference Rule

- If the Clock Reference is set to *Internal*, *LTC*, *Pilot Tone*, *Bi-Phase/Tach*, *Digital (AES/EBU), Digital (Super Clock),* or *Digital (Word Clock)*, then the time code generator will lock to the selected clock reference.
- If the Clock Reference is set to one of the two video inputs (*Video Ref In* or *Video In*), then the time code generator will reference the *Video Ref In* connector.

You may wonder why, if the clock reference pop-up menu is set to *Video In*, the time code generator still takes its positional reference from *Video Ref In*. The reason is that this way, the Universal Slave Driver's can take its clock source from either video input, and time code will reference the frame edge from the *Video Ref In* connector (typically, black burst signal).

## LTC Generation/Regeneration

As described earlier, the Universal Slave Driver will regenerate LTC whenever the external positional reference is moving at normal, 1x forward speed (± 10%).

***To regenerate LTC based upon an external positional reference:***

1. Ensure that the Universal Slave Driver's LTC output is connected to an appropriate audio input or time code input of a "destination" device (the device onto which you wish to record LTC).
2. Next, set the level of the LTC analog signal. To do this, select the desired level (–24 dBu to +9 dBu) from the USD Setup's *LTC Output Level* pop-up menu. If you're in doubt, set the signal to –10 dBu.
3. Set the input level of the destination device to record LTC at an appropriate level. Certain consumer-grade devices may require a relatively low level, to minimize the chance of crosstalk onto other audio tracks. If the incoming signal remains too "hot," then reduce the Universal Slave Driver's LTC output level, as described in Step 2.
4. In USD Setup's *Positional Ref* pop-up menu, select the desired external positional reference (any choice except *Generate*).
5. The Universal Slave Driver will now begin regenerating LTC as soon as it receives a valid positional reference signal.

The Universal Slave Driver can also generate LTC in Generator Preset Mode—using its integral time code generating feature (Positional Reference = *Generate*)—allowing the Universal Slave Driver to function as a complete stand-alone time code generator. In this mode, you can use either an external clock reference, or the Universal Slave Driver's internal crystal as a clock reference. When generating LTC, you can set any desired start time. Refer to the above *Generator Reference Rule*, when choosing to which clock source the generator will resolve (lock).

***To generate LTC internally:***

1. Ensure that the Universal Slave Driver's LTC output is connected to an appropriate audio input or time code input of a "destination" device (the device onto which you wish to record LTC).
2. Next, set the level of the LTC analog signal. To do this, select the desired level (–24 dBu to +9 dBu) from the USD Setup's *LTC Output Level* pop-up menu. If you're in doubt, set the signal to –10 dBu.
3. Set the input level of the destination device to record LTC at an appropriate level. Certain consumer-grade devices may require a relatively low level, to minimize the chance of crosstalk onto other audio tracks. If the incoming signal remains too "hot," then reduce the Universal Slave Driver's LTC output level, as described in Step 2.
4. In USD Setup's *Positional Ref* pop-up menu, select *Generate*.

5. In USD Setup's *Generator/Bi-Phase Preset* window, type in the desired time code start time, in *Hrs:Min:Sec:Frm*. If you wish to start at *00:00:00:00*, click *Zero*. Most post-production facilities in the U.S. use one-hour boundaries to define start points that are greater than *00:00:00:00* for program material. As a good practice, when arbitrarily setting a time code start address for your work, we recommend that you use *01:00:00:00* or greater. This avoids problems that can occur with time code addresses that cross the 24-hour or "midnight mark" (the address point between *23:xx:xx:xx* and *00:00:00:00*). When you are finished inputting the desired start time (or clicked *Zero*), click *Set*.

6. You are now ready to begin generating LTC. Typically, at this point you would arm the destination ATR or VTR to record LTC on one of its audio tracks.

7. If you've selected *Internal* as the clock reference, all you need to do is click *Run*. If you've selected an external clock reference, however, that reference will need to be running into the Universal Slave Driver before you can click *Run*.

8. When you have finished generating the desired length of LTC, click *Stop* to stop generating.

## More about VITC Generation/Regeneration

Working with VITC is considerably more complicated than working with LTC. One important difference is that whereas the Universal Slave Driver will output LTC using any clock or positional reference, your choices are more limited when it comes to outputting VITC—due to the very nature of VITC.

Furthermore, when you use the Universal Slave Driver to regenerate VITC (based upon an external positional reference)—or to generate VITC (based upon its internal, crystal time code generator)—you'll be inserting VITC into an existing video signal.

For instance, a common situation would be where you wish to insert VITC while transferring video from a "source" VTR (or a nonlinear video editing system) to a "destination" VTR (or a nonlinear video editing system). With this arrangement, you would connect the video source signal to one of the Universal Slave Driver's video input connectors. The choice of which video input connector to use depends on the following rule:

**VITC Video Source Rule**

- When the Universal Slave Driver is in Generator Preset Mode (Positional Reference = *Generate*)—and the clock reference is either *Video In* or *Video Ref In*—then the time code reference used for VITC insertion will be derived from the *Video Ref In* connector. (This is because the Universal Slave Driver's time code generating circuitry is not switchable from the *Video Ref In* connector.)

- In all other combinations of positional reference and clock reference, the time code reference used for VITC insertion will be derived from the *Video In* connector.

Next, once you've configured your video source, you'll want to route the Universal Slave Driver's *Video Out* signal to the destination VTR or other device. In this way, the Universal Slave Driver will be able to stripe the second VTR's videotape with VITC. (At the same, you might also wish to insert a window burn, as described later in this chapter.)

*Note: Unlike LTC, the Universal Slave Driver can regenerate VITC with both forward and reverse time code addresses.*

In order for the Universal Slave Driver to regenerate VITC based upon an external positional reference, you'll need to select both a clock reference (see above for the *VITC Video Source Rule*) and a positional reference.

***To regenerate VITC based upon an external positional reference:***

1. Ensure that the Universal Slave Driver is connected in-line with a video source and video destination, as described just above.
2. Ensure that *VITC Insertion Enabled* is checked in the USD Setup window, and that you have selected the appropriate format from the *Video Format* pop-up window (*NTSC* or *PAL*).
3. Now you'll select onto which line pair you'll be generating VITC. As described earlier in this chapter, the available line pairs range from *10/12* through *20/22*. Both the Universal Slave Driver and USD Setup are preset to use line pair *14/16*, which is the default choice for the USD. To change the line pair, go to USD Setup's *VITC Generate Lines* pop-up menu, and make your selection.
4. Select the appropriate clock reference, using USD Setup's *Clock Ref* pop-up window. (Don't forget the VITC Video Source Rule, so that you know onto which video input signal the VITC will be applied.)
5. Next, select one of the following positional references, using USD Setup's *Positional Ref* pop-up window:
   - *LTC*; or
   - Bi-Phase/Tach.

*Note: Because it is impossible for the Universal Slave Driver to read from and write to the same line in a video picture, you cannot use an external VITC source as a positional reference to regenerate new VITC. Furthermore, if you wish to use LTC as a positional source, do not select Auto-Switch LTC/VITC.*

6. The Universal Slave Driver will now regenerate VITC and insert it onto the video signal (as soon as it receives a valid clock reference signal and positional reference signal).

***To generate VITC internally:***

1. Ensure that the Universal Slave Driver is connected in-line with a video source and video destination, as described just above.
2. Ensure that *VITC Insertion Enabled* is checked in the USD Setup window, and that you have selected the appropriate format from the *Video Format* pop-up window (*NTSC* or *PAL*).
3. Now you'll select onto which line pair you'll be generating VITC. As described earlier in this chapter, the available line pairs range from *10/12* through *20/22*. Both the Universal Slave Driver and USD Setup are preset to use line pair *14/16*, which is the default choice for the USD. To change the line pair, go to USD Setup's *VITC Generate Lines* pop-up menu, and make your selection.
4. Select the appropriate clock reference, using USD Setup's *Clock Ref* pop-up window. (Don't forget the VITC Video Source Rule, so that you know onto which video input signal the VITC will be applied.)
5. Next, you'll configure the Universal Slave Driver to generate time code internally, without using an external positional reference. Using USD Setup's *Positional Ref* pop-up window, select *Generate*.

6. In USD Setup's *Generator/Bi-Phase Preset* window, type in the desired time code start time, in *Hrs:Min:Sec:Frm*. If you wish to start at *00:00:00:00*, click *Zero*. After you've input the desired start time (or clicked *Zero*), click *Set*.

7. You are now ready to begin generating VITC, which will be inserted into the video signal. Typically, at this point you would arm the destination VTR to record video, so that VITC can be inserted into the video signal, and be recorded on the destination videotape.

8. Make sure that your chosen clock reference is actually present and running, and that is synchronized with the incoming video signal, then click the *Run* button. The time code addresses will begin to increment smoothly.

9. Click the *Stop* button when you want to pause or stop the generating process.

*Note: Regardless of whether you are generating or regenerating, an active video signal will need to be present at one of the Universal Slave Driver's video inputs (refer to the VITC Video Source Rule earlier in this chapter). Remember, if the source of your video is a VTR/VCR, and if the heads disengage from the source video tape during an extended pause, you'll need to press pause again, or start the video tape, in order to generate VITC. And of course, the video signal will need to be playing in order to actually record VITC into the video signal.*

**VITC Timing Rule**

There's another important rule for you to consider whenever you are generating or regenerating VITC. It may seem esoteric, but it is important for successful VITC insertion:

**VITC Timing Rule**

- Inserted VITC—regardless of whether it is being regenerated (derived from an external positional reference such as LTC), or being generated (Generator Preset Mode)—should be *monotonic*.

By "monotonic," we mean that the VITC should be smoothly ascending or descending, with no repeated or skipped frame addresses. In order to achieve monotonicity, the external positional reference (while regenerating) or the clock source (in Generator Preset Mode) must be synchronous with the video signal onto which the VITC is being inserted.

As an example, if you are using LTC as a positional reference from a 3/4-inch U-Matic VTR, then that VTR should be referenced to the same video signal that you are applying to the Universal Slave Driver. As another example, in Generator Preset Mode (Positional Reference = *Generate*), a clock reference of Internal is not a good choice, simply because the Universal Slave Driver's internal crystal runs asynchronously with respect to the supplied video signal, and thus repeated or skipped frame addresses are sure to eventually occur.

### MTC Generation/Regeneration

MIDI Time Code is a serial digital signal. In many ways, you can think of it as an inaudible type of LTC, that can be used by various MIDI devices. Similarly to LTC, MTC also conveys time addresses in terms of hours:minutes:seconds:frames.

MTC shows up at the Universal Slave Driver's *MTC Out* connector, which is a standard DIN-style 5-pin female MIDI connector. To use MTC, you'll need to connect *MTC Out* to a MIDI In connector of a device that can recognize and use MTC. Typically, this would be a MIDI interface used in conjunction with Mac or PC sequencing software. Alternately, it could be an outboard "hardware" sequencer, a synthesizer or sampler keyboard with a built-in sequencer, or a drum machine.

MTC is output from the Universal Slave Driver at all times that LTC is output. This means that regardless of whether LTC is being output in Generator Preset Mode (Positional Reference = *Generate*) or while regenerating (Positional Reference = *LTC*, *VITC*, *Auto-Switch LTC/VITC*, or *Bi-Phase/Tach*), MTC is simultaneously output in parallel with that LTC.

However, it is possible for the Universal Slave Driver to output MTC without outputting LTC: Should the Universal Slave Driver stop outputting LTC, it will continue to output MTC in "bursts" of one frame every 200 milliseconds. The Universal Slave Driver does this so that any connected MIDI-reading device can be continuously updated as to the position of VITC or Bi-phase (either of which might be operating at slow or still speeds). Thus, you can still use a connected MIDI device for Auto-Spotting from VITC or Bi-phase.

## Generating a Window Dub

The Universal Slave Driver offers the feature of window dubbing, which superimposes onto a video signal a small, visible area—called a *window dub*, or *window burn*, or *time code window*—that displays time code in hours:minutes:seconds:frames.



Here's what a window dub looks like once it's been "burned" onto a video image:


*Video image with window burn*

A window dub can be very helpful for anyone involved in audio-for-picture, since it gives you an instant, visual cue as to where you are in time.

When working with Pro Tools, for instance, you can use a window dub to help you locate a particular video frame that has been "cued" by the director for a particular sound effect. Or, if you're in Pro Tools' Spot mode, and you want to spot a region to the same video frame at which you've paused your videotape, you can simply type in the time code reading you see in the window dub. (This is especially useful if your only time code reference from the tape is LTC—in order to use Auto-Spotting in Pro Tools when the videotape is paused, you'll need VITC.)

With the Universal Slave Driver, the window dub's time code addresses are derived from the positional reference. In other words, if you've chosen an external reference, such as LTC or VITC, the window dub's readings reflect those of the incoming time code; if you've chosen to generate time code internally (i.e., your positional reference is set to *Generate*), then the window dub will start its address from whatever you've set as the Generator/Bi-Phase Preset start time.

*Note: In order to use a window dub properly, its addresses will need to be accurate. Consequently, assuming you want the window dub's readings to match the actual LTC or VITC time code that's associated with the video image, be sure you choose the correct positional reference. For instance, it's quite common to stripe a video signal simultaneously with VITC and a window dub. In this case, since VITC cannot be regenerated from a VITC positional reference, you'll want to ensure that you're using LTC (or Bi-Phase/Tach) as your positional reference.*

As with regenerating VITC, the Universal Slave Driver can only burn a window dub onto an existing video signal. This means that at least one video "source" signal (from a VTR, nonlinear editing system, or other video device) will need to be present at one of the Universal Slave Driver's video input connectors (*Video In* or *Video Ref In*). When generating a window dub, the two rules mentioned in the VITC section—the *VITC Timing Rule* and the *VITC Video Source Rule*—also apply. Finally, a signal from the Universal Slave Driver's *Video Out* connector will need to be routed to a video "destination" (such as another VTR or nonlinear editing system).

***To burn a window dub onto a video signal:***

1. In the *Dub Window* section of USD Setup, check the *Window Enabled* box.
2. Choose the "look" of the window dub from the *Vertical Position*, *Horizontal Position*, and *Color* pop-up menus. (For details about the options, please review "A Tour of the USD Setup Window" section in the beginning of this chapter.)
3. Ensure that all the proper video connections have been made, and that you've selected the correct positional reference.

After you have completed these steps, you'll burn a window dub—with time code addresses based upon the selected positional reference—onto any video signal that's passing through the Universal Slave Driver.

***To turn off window dubbing:***

1. Simply uncheck the *Window Enabled* box.

## Managing & Selecting Video Inputs: An Overview of the Video Input Rules

**(for USD Setup only)**

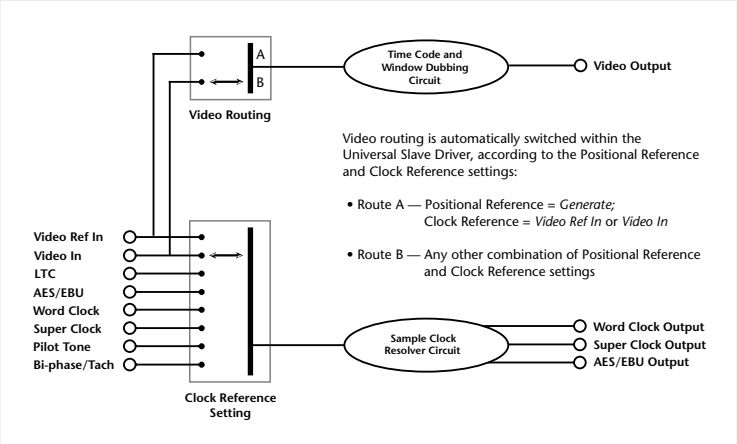
The Universal Slave Driver has two integrated video inputs, which are used for *both* clock reference and positional (time code) reference:

- *Video Ref In* — intended to receive a black burst (house sync) signal, for clock reference purposes.
- *Video In* — intended to receive an "ordinary" video signal, which can supply a clock reference (when synchronizing to the video clock), a positional reference (when synchronizing to VITC), and a video source (onto which regenerated VITC and a window dub can be inserted).

When you are using the Universal Slave Driver in conjunction with the USD Setup application, either video input can be chosen as the clock reference. However, certain rules apply that can affect which signal is referenced for time code generation, and onto which signal a window dub or VITC may be inserted. Let's review the video input rules covered throughout this chapter:

| | **If the front-panel *Clock Reference* switch is set to:** | **...and the front-panel *Positional Reference* switch is set to:** | **...and this parameter is enabled:** | **...then this video input is used:** |
|---|---|---|---|---|
| **Video Inputs & Generator Reference Rule** | *Video* | *Generate* | n/a | *Video Ref In* |
| | *Video* | Other than *Generate* | n/a | *Video In* |
| **Video Inputs & Window Dubbing Rule** | *Video* | *Generate* | *Window dubbing* | *Video Ref In* |
| | Any combination other than *Video* and *Generate* | | *Window dubbing* | *Video In* |
| **Video Inputs & VITC Video Source Rule** | *Video* | *Generate* | n/a | *Video Ref In* |
| | Any combination other than *Video* and *Generate* | | n/a | *Video In* |

To understand why these rules exist, let's examine how the circuitry works within the Universal Slave Driver:




The clock reference (labelled *Sample Clock Resolver Circuit* in the illustration above) is switchable at all times. You can decide which input signal to use to generate the digital clock signal.

However, when the clock reference is set to *Video In* or *Video Ref In,* the positional (time code) reference circuitry (labelled *Time Code and Window Dub Circuit* in the illustration) is not switchable. This is because the positional (time code) reference circuitry is always used to derive time code, whether the Universal Slave Driver is reading incoming time code or generating new time code. Even in *Generate* mode, the Universal Slave Driver needs to use this circuitry to detect the frame edge of the video, in order to generate time code.

Consequently, this circuit can also determine the *Video* clock reference setting that you need to use:

- When using a video signal for clock reference, and the positional reference is set to *LTC*, *VITC*, *Auto-Switch LTC/VITC* or *Bi-Phase*, the positional (time code) reference circuitry refers to the *Video In* connector for timing information (labelled *Video Route B* in the illustration.) Therefore, make sure the video signal is routed to the *Video In* connector, and the clock reference is set to *Video In*.
- When using a video signal for clock reference, and the positional reference is set to *Generate*, the positional (time code) reference circuitry refers to the *Video Ref In* connector for timing information. In this case, make sure the video signal is routed to the *Video Ref In* connector, and the clock reference is set to *Video Ref In*.

It is important to know that if you are using a separate video signals for video reference (black burst) and for program material, these signals will function expectably when connected to the appropriate video inputs: black burst to the *Video Ref In* connector, and program material to the *Video In* connector. All applications will function expectably in this situation.

If you only have program material video (without a separate video reference signal) and you want to generate new time code referenced to this signal, you must connect this video source to the *Video Ref In* connector. Additionally, if you also want to overlay a window burn or insert VITC, connect either a video monitor or the recording video deck to the *Video Out* connector.

## Conclusion

This concludes the chapter on using the USD Setup software to control the Universal Slave Driver. The next chapter describes how to operate the Universal Slave Driver using its front panel controls. While the next chapter repeats much of the information included in this chapter, pertinent information will be close at hand, regardless of whether you choose to operate your Universal Slave Driver using the USD Setup software or the front panel controls. If you're comfortable using USD Setup, and don't intend to use the Universal Slave Driver's front panel controls, feel free to skip the next chapter.

# Operating the Universal Slave Driver Using the Front Panel (Local Control)

# Operating the Universal Slave Driver Using the Front Panel (Local Control)

4

## Introduction

In this chapter, we'll review how to operate your Universal Slave Driver using its front-panel controls.

As we've emphasized, using USD Setup software is the easiest way to configure and operate your Universal Slave Driver. However, there may be circumstances where it is not practical to connect a Macintosh computer to the Universal Slave Driver, or where you may be "setting and forgetting" the Universal Slave Driver. For these reasons, most of the Universal Slave Driver's features can be accessed directly from its front-panel controls, without having to connect it to a Mac, or use USD Setup.

*Note: If you plan to operate your Universal Slave Driver using USD Setup software exclusively, feel free to skip this chapter. This is because much of the information in this chapter is a repetition of what was covered in the preceding chapter, "Operating the Universal Slave Driver Using USD Setup Software." Since most users will be operating the Universal Slave Driver using either USD Setup or the front panel controls, we've organized the manual in this fashion so that pertinent information will be close at hand, regardless of which method you use to operate your Universal Slave Driver.*

## How to Use This Chapter

This first half of this chapter is a reference section for the Universal Slave Driver's front-panel controls—offering a basic description of what each control is, where it's located, and where applicable, how to operate it. We suggest you refer to this part to familiarize yourself with the Universal Slave Driver's front panel, and whenever you need a quick "refresher" on which control does what.

The second half of this chapter is more tutorial-oriented, with more detailed discussions of how the controls operate, and which settings and parameters to use in difference circumstances. We suggest you refer to this part to gain an in-depth understanding of the Universal Slave Driver's controls and applications.

## Using the Universal Slave Driver's Front Panel Controls in Conjunction with the USD Setup Software

If you are controlling your Universal Slave Driver with USD Setup software, and you have selected the default *Remote-Only Mode (Front Panel Lockout)* in the software's *USD Setup Preferences* window, then none of the Universal Slave Driver's front panel controls will be operational. Control of the Universal Slave Driver would be only accessible *remotely* from USD Setup. Additionally, if you are using USD Setup to control the Universal Slave Driver which is installed in your machine room, locking out the front panel will prevent someone from inadvertently changing the Universal Slave Driver's front-panel settings.

Keep in mind that even if you've chosen *Remote-Only Mode (Front Panel Lockout)*, the front panel LED Time Code Display—and all of the status LEDs—will reflect the whatever settings you've selected using USD Setup. The *Remote Only* LED will also light up.

*User Tip: By simultaneously holding down the Clock Reference, Positional Reference, and Frame Rate front-panel switches, you can disengage the Universal Slave Driver from Remote-Only Mode. This is useful when the host CPU is not easily accessible to override Remote-Only Mode.*

On the other hand, if you have not selected *Remote-Only Mode (Front Panel Lockout)*, then you will be able to operate the Universal Slave Driver using *both* USD Setup and the front panel controls. In this situation, when you make a change in one place (in USD Setup or the front panel controls), it "updates" the other. For example, if you change the clock reference using the front panel Clock Reference switch, USD Setup's *Clock Ref* pop-up menu will reflect the change.

### Features Not Accessible from the Universal Slave Driver's Front Panel Controls

Some of the Universal Slave Driver's features are not accessible using its front panel controls—and can only be accessed using the USD Setup software, or other application software.

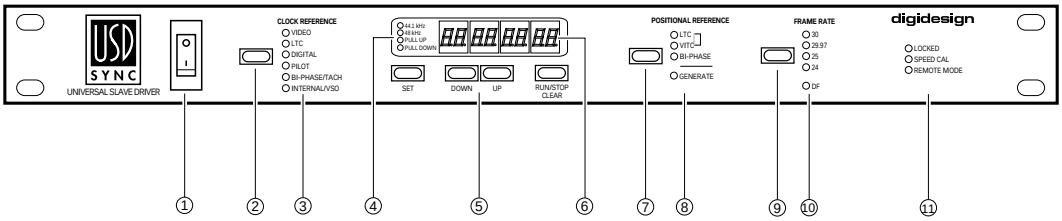
These inaccessible features include:

- turning on Remote-Only Mode/Front Panel Lockout (see Chapter 3);
- updating the Universal Slave Driver's firmware (see Chapter 3);
- changing the settings of the Size, Vertical Position, Horizontal Position, and Color for the Window Dub (see Chapter 3);
- setting any GPI (General Purpose Interface) functions (see Chapter 1);
- choosing either the *Video In* or *Video Ref In* connector for the Clock Reference source (see the *"Managing & Selecting Video Inputs: An Overview of the Video Input Rules"* section later in this chapter);
- the 9-pin Pass-through feature (see Chapter 1); and
- the Variable Speed Offset (VSO) feature (see Chapter 3).

*Note: Unlike many other settings, VSO settings are not recalled when the Universal Slave Driver is powered down and powered up again. In other words, if you use USD Setup's VSO function—and then close USD Setup, and turn off power to the Universal Slave Driver—the VSO settings will be lost when the Universal Slave Driver is powered up next.*

## A Tour of the Universal Slave Driver's Front Panel

All of the Universal Slave Driver's local controls are on its front panel; the rear panel is reserved for connectors only. (For information on rear panel connectors, please refer to Chapter 2.)




### 1. AC Mains Power Switch

In the down position (" | "), the Universal Slave Driver's power is on; in the up position ("O"), the power is off. This is the only front panel control that's not replicated within USD Setup.

### 2. Clock Reference Switch

This momentary switch is used to select the Universal Slave Driver's clock reference.

***To select a clock reference for the Universal Slave Driver:***

1. Push and release the Clock Reference switch to cycle the Universal Slave Driver through its available clock references, which include:
   - Video (depending upon how the Universal Slave Driver is configured, this clock reference may be the *Video Ref In* or the *Video In* connector; for more details, see the *"Managing & Selecting Video Inputs: An Overview of the Video Input Rules"* section later in this chapter);
   - Digital (AES/EBU, Super Clock, or Word Clock; see the "Digital Clock Reference" section later in this chapter to learn how to select the digital clock type);
   - Linear Time Code (LTC);
   - Pilot Tone;
   - Bi-Phase/Tach; or
   - Internal/VSO.
2. The active choice will be displayed by one of the Clock Reference LEDs. This choice will also be recalled when the Universal Slave Driver is powered down and powered up again.

Unlike USD Setup's *Clock Ref* pop-up menu, the Universal Slave Driver's front panel Clock Reference Switch does not let you choose directly between the two *Video* and three *Digital* clock references. However, you can use the four Generator/Parameter Switches (described shortly) to select specific parameter choices.

The *Locked* LED (on the front panel's far-right) will flash on and off if the chosen clock reference source is unavailable, or the current configuration is not valid. (For instance, the Universal Slave Driver is unable to read or produce a valid clock reference.)

#### 3. Clock Reference LEDs

These green-colored LEDs display the active clock reference, as selected with the Clock Reference Switch. Only the current source will be illuminated.

#### 4. Sample Rate LEDs

These green-colored LEDs show the selected audio sample rate, as selected with the Generator/Parameter Controls (described next). The two primary Sample Rate LEDs are *44.1 kHz* and *48 kHz*.

Two additional LEDs show whether the sample rate is in *Pull Up* or *Pull Down* mode, to compensate for pitch discrepancies in film-to-NTSC video transfers (as described in Chapter 1). When the Universal Slave Driver is set for 44.1 kHz, the respective pull-up and pull-down rates are 44.144 kHz and 44.056 kHz. When the Universal Slave Driver is set for 48 kHz, the respective pull-up and pull-down rates are 48.048 kHz and 47.952 kHz.

*Note for PAL video-format users: The Universal Slave Driver's pull-up/pull-down features are not designed to perform 24 fps-to-25 fps (and vice-versa) conversions.*

#### 5. Generator/Parameter Controls

These four momentary-type switches (*Set*, *Down*, *Up*, and *Run/Stop • Clear* ) provide access to the Universal Slave Driver's time code generator/regenerator features. They are also used for setting many of the Universal Slave Driver's other functions, as described below.

We'll review the details of how to adjust the time code generator—and other Universal Slave Driver functions—in the next section. For now, here's an overview of how the four Generator/Parameter Controls work.

*Set*
This switch is used for entering data, and has three primary functions:

- When time code numbers are visible in the LED Time Code Display, pushing *Set* once will change the Display from showing time code numbers to showing parameter names. (Here, pushing the *Down* and *Up* switches will scroll through the parameter names, from *SET GEn* to *VIdEo SY*.)
- When a parameter name is visible in the LED Time Code Display, pushing *Set* once will change the Display from showing parameter names to showing parameter values, such as *PAL*. (Here, pushing the *Down* and *Up* switches will scroll through the respective parameter values.)
- When a parameter value is visible in the LED Time Code Display, pushing *Set* once will "set" that parameter value, and will return the Display to showing time code numbers.

*Down* and *Up*
These switches are used for scrolling through parameter names and parameter values:

- When a parameter name is visible in the LED Time Code Display (by pushing *Set* as described above), pushing the *Down* and *Up* switches will scroll through the parameter names, from *SET GEn* to *VIdEo SY*.
- When a parameter value is visible in the LED Time Code Display (by pushing *Set* as described above), pushing the *Down* and *Up* switches will scroll through the respective parameter values.

- When entering time code values for the generator start time, simultaneously pushing the *Down* and *Up* switches will tab you through the "hours:minutes:seconds:frames" fields.

*Note: When scrolling with the Down and Up switches, the parameter names and values will not "cycle." For instance, when you reach the last name or value, continuing to push the Up switch will have no effect, and to return to the first name or value, you'll need to press the Down switch. This approach is common with many types of equipment, and allows you to know how many times to push the Down or Up buttons to access a certain name or value.*

*Run/Stop • Clear*
This switch has two functions, depending upon the current mode:

- *Run/Stop*: When generating time code, with the Universal Slave Driver in *Generator Preset Mode* (as detailed later in this chapter), pushing this switch will start or stop the time code generator.
- *Clear*: When entering time code values using the *Set*, *Up*, and *Down* switches, pushing *Clear* will reset the LED Time Code Display to *00:00:00:00*. When setting parameters other than the Generator Preset, *Clear* functions as a *Cancel* button.

### 6. LED Time Code Display

This 7-segment, multifunction display will indicate several types of information, including:

- The Universal Slave Driver's current positional reference (internal or external), in hours:minutes:seconds:frames.
- Which video field is providing the VITC positional information (at slow crawl speeds). For instance, when your jogging a videotape slowly from frame to frame, or when you "park" the videotape on a particular frame, it may be useful for you to know which of that frame's two video fields you're reading. To show this, the LED Time Code Display's decimal points next to "seconds" and "frames" may change, as follows:

  - when the video field is even-numbered, the decimal point to the right of "frames" will light;
  - when the video field is odd-numbered, the decimal point to the right of "frames" will darken;
  - when the Universal Slave Driver is in Auto-Switch LTC/VITC mode, the decimal point to the right of "minutes" will light;
  - only when displaying Window Dub and VSO setup on the front panel and when the Universal Slave Driver is reading odd-numbered fields (1, 3, 5, 7, etc.), the decimal point between "seconds" and "frames" will light; and
  - only when displaying Window Dub and VSO setup on the front panel and when the Universal Slave Driver is reading even-numbered fields (2, 4, 6, 8, etc.), the decimal point between "seconds" and "frames" will darken.

### 7. Positional Reference Switch

This momentary switch is used to select the Universal Slave Driver's positional reference.

***To select a positional reference for the Universal Slave Driver:***

1. Push and release the Clock Reference switch to cycle the Universal Slave Driver through its available clock references, which include:
   - Linear Time Code (labelled *LTC*);
   - Vertical Interval Time Code (labelled *VITC*);

- Auto-Switch LTC/VITC (labelled with a line joining the *LTC* and *VITC* Positional Reference LEDs, and set when both LEDs are illuminated);
- Bi-phase/Tach (labelled *Bi-phase*); or
- *Generate* — for generating time code internally (with the Universal Slave Driver as the master time code source).

2. The active choice will be displayed by one of the Positional Reference LEDs. This choice will also be recalled when the Universal Slave Driver is powered down and powered up again.

In *Auto-Switch LTC/VITC* mode, the Universal Slave Driver will automatically switch between LTC and VITC sources, to obtain the best positional reference (since VITC presents reading problems at high tape speeds, and LTC cannot be read when the external device is paused). Auto-Switch LTC/VITC mode is described in greater detail later in this chapter.

When *LTC* or *VITC* (or *Auto Switch LTC/VITC*) is chosen for the positional reference, the Universal Slave Driver will regenerate time code that corresponds directly to the incoming LTC or VITC.

When *Bi-Phase/Tach* is chosen for the positional reference, then the Universal Slave Driver will generate time code in relation to the Generator/Bi-Phase Preset value (discussed later in this chapter).

### 8. Positional Reference LEDs

These yellow-colored LEDs display the active positional reference, as selected with the Positional Reference Switch.

The current source will be illuminated, with the exception of Auto Switch LTC/VITC mode. In this mode, both the *LTC* and *VITC* LEDs will be illuminated—but only prior to feeding the Universal Slave Driver any time code. Once the Universal Slave Driver detects active LTC or VITC, it will "decide" which time code provides the most accurate address, and either the *LTC* or the *VITC* LED will illuminate.

For instance, let's say you plan to resolve the Universal Slave Driver to a videotape that's striped with both LTC and VITC. When you select the Auto Switch LTC/VITC mode, both the *LTC* and *VITC* LEDs will be illuminated when the VTR stopped or paused. Once you start the tape playing, the Universal Slave Driver will typically choose LTC as its source, and the *LTC* LED will light up. However, once you pause the tape or jog the tape at a slow speed, LTC can no longer be read; at this point, the Universal Slave Driver would switch to VITC as the source, and the *VITC* LED would light up.

### 9. Frame Rate Switch

This momentary switch is used to select the time code frame rate and format (drop-frame or non drop-frame).

***To select a time code frame rate for the Universal Slave Driver:***

1. Push and release the Frame Rate switch to cycle the Universal Slave Driver through its available clock references, which include:
   - 30 fps;
   - 30 fps drop-frame;
   - 29.97 fps;
   - 29.97 fps drop-frame;
   - 25 fps; or
   - 24 fps.

2. The active choice will be displayed by one of the Frame Rate LEDs. This choice will also be recalled when the Universal Slave Driver is powered down and powered up again.

#### 10. Frame Rate LEDs

The Frame Rate LEDs show whatever selection you've made with the Frame Rate Switch. The frame rates (30, 29.97, 25, or 24 fps) are indicated by four green-colored LEDs; the format (non-drop-frame or drop-frame) is indicated by a single orange-colored LED labelled *DF*, which illuminates only if you've chosen drop-frame format.

#### 11. Status LEDs

Show the current state of the Universal Slave Driver in relation to clock references. Indicators include:

- *Locked* — a red LED that's highlighted when the Universal Slave Driver is locked to the chosen external clock reference, or to its "Internal" clock reference.
- *Speed Cal* (Speed Calibration) — a yellow LED that's highlighted when the Universal Slave Driver's system clock and all output clocks are at a frequency that corresponds with the chosen sample rate.

The Speed Cal LED provides an indication of an external clock source's speed accuracy. For instance, if the incoming clock reference is running moderately off-speed (if an audio tape is set to varispeed or is otherwise off-speed), this indicator will flash quickly (if too fast) or slowly (if too slow). The Speed Calibration indicator will be lit steadily only if the incoming clock is within ± 0.025% (250 parts per million) of accurate play speed. If the speed is greater than +0.025%, the indicator will flash quickly; if the speed is less than –0.025%, the indicator will flash slowly.

Other status indicators can be found in the USD Setup.

*Note: Relatively new professional ATRs should be able to play back with a speed deviation of less than –0.025%. Some ATRs, even when calibrated properly, may not run accurately enough to allow the Speed Calibration to remain highlighted without flashing. In general, users of semiprofessional or older ATRs should not be alarmed if Speed Calibration does not remain highlighted (assuming there are no problems with the ATR, such as a mis-calibrated motor, or an exceptional amount of "gunk" on the heads or tape path). Of course, resolving ATRs using a professional synchronizer such as a Lynx module is the recommended way of working.*

- *Remote Mode* — a green LED that's highlighted when the Universal Slave Driver is set to *Remote-Only Mode (Front Panel Lockout).*

## Selecting Parameter Names and Values Using the Generator/ Parameter Controls

The Universal Slave Driver's *Clock Reference*, *Positional Reference*, and *Frame Rate* switches are used for selecting their respective values. The Generator/Parameter Controls (*Set*, *Down*, *Up*, and *Run/Stop•Clear*) are used for selecting all of the Universal Slave Driver's other parameter names and parameter values.

When time code numbers are visible in the LED Time Code Display, pushing the *Set* switch once will display the first parameter name, "Set Gen," for setting the time code generator:

Depending upon the last state of the Universal Slave Driver, you may see a readout other than *SEt GEn*. If this is the case, press *Down* to show this name.

*Note: Reading parameters within the Universal Slave Driver's LED Time Code may be a little difficult. This is because 7-segment LEDs are not able to show all upper- and lowercase characters properly, and in some cases use numerals to represent letters (such as "5" to represent "S" or "s"). To make reading easier, this manual will show you parameter settings in their "LED" version, along with a proper alphabetic "translation."*

If you press *Up*, you will begin scrolling through the different parameter names, starting with Digital Reference (*di6 rEF*), and ending with Video System NTSC/PAL (*VIdEo SY*). Pressing *Down* will scroll you back through the parameters. Holding down the *Up* or *Down* switch quickly scrolls through the parameters.

Once you find a parameter you wish to change, pressing *Set* will access that parameter's current setting; at this point, pressing *Up* or *Down* will now cycle you through the available values.

For example, let's say we want to use the Universal Slave Driver's front panel controls to change its Linear Time Code output level.

***To select a parameter name and change its respective parameter values:***

1. To begin, time code numbers (i.e., *00:00:00:00*) should be visible in the LED Time Code Display. If you don't see them, press the *Set* switch until you do.
2. Press the *Set* switch. The LED Time Code Display will switch from showing time code numbers to a parameter name. The first name is Set Generator (*SE7 6En*), although you may see a different name, depending upon the Universal Slave Driver's last settings.
3. Press the *Down* or *Up* switches until the LED Time Code Display shows LTC Gain (*L7C 6AIn*).

*Note: LTC Gain is what we'll use in this example, but the following steps will apply similarly to changing most parameter values.*

4. Press the *Set* switch again. The LED Time Code Display will now show the current parameter value for LTC Gain in dBu (*dbu*) values.
5. Now press the *Down* or *Up* switches to scroll through the available parameter options. In this case, the values will scroll (in 3 dBu steps) from a lowest gain level of –24 dBu to a highest gain level of +9 dBu. Pressing and holding the *Down* or *Up* switches will scroll you quickly through the values. Alternately, you can press and release the switch to jump one parameter value at a time.
6. When you've selected the parameter value you want (for example, –10 dBu), press the *Set* switch once again. This will "lock in" the parameter value, and will return the LED Time Code Display to showing time code numbers.
7. At this point, you have re-configured the Universal Slave Driver. It will remember this setting until you change it, either using the front-panel controls or the USD Setup software.

With just a few exceptions—which will be detailed in the coming pages—these steps remain the same for changing all parameter values.

Now let's review each of the parameter names, and their respective parameter values.

*Important Note: Some of the following steps will require you to have already connected the appropriate clock and positional references to the Universal Slave Driver, as described in Chapter 2. You may also need to connect your Universal Slave Driver to your Pro Tools system (or other compatible digital audio workstation). If in doubt, please refer to Chapter 2 for more information.*

### Set Generator Start Time

This serves two functions: First, when the Universal Slave Driver is configured to function as a time code generator (Positional Reference = *Generate*), selecting this parameter name will let you set the start time at which time code will be generated. Once set, pressing the *Run/Stop•Clear* switch will cause the Universal Slave Driver to start generating time code.

Alternately, when the Universal Slave Driver is configured to regenerate time code based upon a Bi-phase/Tach signal (Positional Reference = *Bi-phase/Tach*), selecting this parameter name will let you set the start time at which time code will be regenerated. Once set, the Universal Slave Driver will begin to generate time code as soon as it detects incoming Bi-phase/Tach information. (Setting a preset start time is necessary because Bi-phase/Tach has no positional information of its own. However, given a preset start time code address, the Universal Slave Driver can calculate and generate time code based upon the direction of the Bi-phase/Tach pulses).

***To set the generator start time:***

1. Select Set Gen (*SE7 6En*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).
2. Press the *Set* switch again. The LED Time Code Display will switch to display time code numbers; one of the time code fields (hours:minutes:seconds:frames) will be flashing.
3. When an individual time code field is flashing, you can set its value by pressing the *Down* or *Up* switch. If you press and release the switch, the value will advance by just one hour, minute, second or frame. If you press and hold the switch, the value will begin scrolling. When it reaches its uppermost value (i.e., *23* in the hours field), the value will cycle to the lowest value (i.e., *00*).

*Note: Pressing the Run/Stop•Clear switch at this point will "clear" the time, setting it to 00:00:00:00.*

4. When you have set a time code field to its desired time, press and release the *Down* and *Up* switches simultaneously. This will set the time of the current field, and will move you to the next time code field (which will begin flashing).
5. Repeat steps 3 and 4 until you have finished setting the Universal Slave Driver to the desired generator start time.
6. When you are done, press the *Set* switch again. The LED Time Code Display will stop flashing, and will show the start time you have just set. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

If you are set to use Bi-phase/Tach for the positional reference, the *Up* and *Down* switches can be used to adjust the time code value up and down. This can be useful for "trimming" you time code value, should you notice a synchronization discrepancy.

dI6 rEF

## Digital Clock Reference

The Universal Slave Driver can use one of three possible digital clock references—AES/EBU, Super Clock (256x), or Word Clock (1x). Selecting this parameter name lets you choose which one of the three is the active choice.

***To choose a digital clock reference:***

1. Using the front-panel Clock Reference switch, select *Digital* as the clock reference.
2. Select Digital Reference (*dI6 rEF*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).
3. Press the *Set* switch again. The LED Time Code Display will switch to display one of the three parameter values:
   - AES/EBU (*AES-E8U*); or
   - Super Clock (*256 CLOC*); or
   - Word Clock (*I CLOC*).
4. Use the *Down* and *Up* switches to scroll through the parameters.
5. When you have found your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

SPL FrEC

## Sample Rate/Frequency

Selecting this parameter name lets you choose the Universal Slave Driver's sample rate.

***To choose the sample rate:***

1. Select Sample Frequency (*SPL FrEC*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).
2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the six parameter values:
   - 44.1 kHz (*44100*); or
   - 44.1 kHz pull-down (*44056*); or
   - 44.1 kHz pull-up (*44144*); or
   - 48 kHz (*48000*); or
   - 48 kHz pull-down (*47952*); or
   - 48 kHz pull-up (*48048*).
3. Use the *Down* and *Up* switches to scroll through the parameter values.
4. When you have found your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers, and the appropriate Sample Rate LED(s) will illuminate to the left of the numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

VI7C In5

### VITC Insertion

When selected, VITC will be inserted onto the outgoing video signal—assuming that a video signal is present at the Universal Slave Driver's video input, and that the Universal Slave Driver is in a valid mode for inserting VITC (as described later in this chapter).

***To configure the Universal Slave Driver to insert VITC:***

1. Select VITC Insertion (*VI7C In5*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).
2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the two parameter values:
   - On (*On*); or
   - Off (*OFF*).
3. Use the *Down* and *Up* switches to switch between the parameter values.
4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

Remember to select the line pairs that you will generate VITC on, using the VITC Generate Lines parameter *(6En LInE)*, described shortly.

rdr LInE

### VITC Read Lines

This setting determines which line pair of the incoming video signal the Universal Slave Driver "looks to," in order to read VITC.

***To choose the VITC read lines:***

1. Select VITC Read Lines (*rdr LInE*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).
2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the parameter values:
   - Auto (*ALL-LInE*)—where the Universal Slave Driver will search all lines and select the first valid line pair automatically—or one of the following:
   - *10/12*
   - *11/13*
   - *12/14*
   - *13/15*
   - *14/16*
   - *15/17*
   - *16/18*
   - *17/19*
   - *18/20*
   - *19/21*
   - *20/22*
3. Use the *Down* and *Up* switches to scroll through the parameter values.

4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

### VITC Generate Lines

This setting determines which line pair (of the video signal at the Video Out connector) onto which the Universal Slave Driver inserts VITC. Normally, this should be left at the default setting of *14/16*

***To choose the VITC generate lines:***

1. Select VITC Generate Lines (*6En LInE*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).

2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the parameter values:

   - *10/12*
   - *11/13*
   - *12/14*
   - *13/15*
   - *14/16* (SMPTE recommended setting)
   - *15/17*
   - *16/18*
   - *17/19*
   - *18/20*
   - *19/21*
   - *20/22*

3. Use the *Down* and *Up* switches to scroll through the parameter values.

4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

### Window Dub/Burn

By enabling this setting, you can superimpose a window dub onto an incoming video signal (assuming the Universal Slave Driver is configured correctly for window dubbing, as described in detail later in this chapter).

***To enable or disable the Universal Slave Driver's window dubbing feature:***

1. Select Burn Enabled (*burn EnA*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).

2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the two parameter values:

   - On (*On*); or
   - Off (*OFF*).

3. Use the *Down* and *Up* switches to switch between the parameter values.

4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

Please note that *only* the USD Setup application allows you to adjust the window dub's size, vertical position, horizontal position, and color. These parameters cannot be adjusted from the Universal Slave Driver's front-panel controls. Assuming these parameters have not been adjusted otherwise using USD Setup, then the Universal Slave Driver will default to the following:

- Size: Large
- Vertical Position: 20% from bottom
- Horizontal Position: Center
- Color: White numerals on a black background.

### Freewheel Length/Duration

Sets the period of time for which the Universal Slave Driver will continue to regenerate time code when incoming time code is interrupted (due to tape drop outs or other errors).

Let's say for instance, our time code rate is 29.97 fps, and we've set a Freewheel Duration of 28 frames. With these settings, incoming time code could drop out for nearly a second, and the Universal Slave Driver would freewheel—that is, continue to generate time code. If the incoming time code was restored before 28 frames elapsed, the Universal Slave Driver would carry on generating time code as if nothing happened. However, if the incoming LTC signal was not restored in time, the Universal Slave Driver would stop generating time code after 28 frames, and the display will revert to the last "good" time code reading. (At this point, if time code is restored, the Universal Slave Driver will resume reading.) The Freewheel Duration is adjustable from 4 frames to 40 frames.

*Note: Freewheel Duration is ignored when the Universal Slave Driver is in internal generate mode.*

***To set the freewheel duration:***

1. Select Freewheel Length (*FrEE LEn*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).
2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the parameter values:
   - *4 Fr*
   - *8 Fr*
   - *12 Fr*
   - *16 Fr*
   - *20 Fr*
   - *24 Fr*
   - *28 Fr*
   - *32 Fr*
   - *36 Fr*
   - *40 Fr*
3. Use the *Down* and *Up* switches to switch between the parameter values.
4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

L7C 6A In

## LTC Output Level/Gain

Used to adjust the audio level of the Universal Slave Driver's LTC output, from –24 dBu to +9 dBu.

***To set the LTC output level:***

1. Select LTC Gain (*L7C 6AIn*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).
2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the parameter values:
   - *9 dbu*
   - *6 dbu*
   - *3 dbu*
   - *0 dbu*
   - *–3 dbu*
   - *–6 dbu*
   - *–9 dbu*
   - *–12 dbu*
   - *–15 dbu*
   - *–18 dbu*
   - *–21 dbu*
   - *–24 dbu*
3. Use the *Down* and *Up* switches to switch between the parameter values.
4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until changed.

PICH HLd

## Pitch Memory/Hold

When selected, the Universal Slave Driver will remain at a "pitch" (i.e. sample rate) that corresponds to the last known clock reference speed. When deselected, the Universal Slave Driver will revert to the selected sample rate. This can be used to resolve the Universal Slave Driver to "off-speed" free-running LTC.

*User Tip: Turn off this if you want to digitally transfer to another device and to ensure the receiving device gets the correct sample rate.*

***To enable or disable the Universal Slave Driver's pitch memory feature:***

1. Select Pitch Hold (*PICH HLd*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).
2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the two parameter values:
   - On (*On*); or
   - Off (*OFF*).
3. Use the *Down* and *Up* switches to switch between the parameter values.
4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

If Pitch Memory is disabled and the selected external clock reference is not available, then the Universal Slave Driver will revert to the nominal, selected *internal* sample rate setting.


### Bi-phase/Tach Pulses Per Frame

This selection is used for specialized applications that involve film or other equipment that output Bi-phase/Tach information. The parameter values set the number of Bi-phase/Tach pulses per frame of time code.

***To set the pulses per frame value for a Bi-phase/Tach signal:***

1. Select Bi-Phase/Tach Pulses Per Frame (*bIPH PPF*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).

2. Press the *Set* switch again. The LED Time Code Display will switch to display the current parameter values, from 2 to 255 pulses per frame. The readout will look something like this:

   *0002*

3. Use the *Down* and *Up* switches to scroll through the parameter values. Pressing and releasing the switches will change the value by just one pulse per frame. Pressing and holding the switches will scroll at a faster speed.

4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.


### Bi-phase/Tach Input Signal

This selection is also used for specialized applications that involve film or other equipment that output Bi-phase/Tach information. Here, the parameter values will be used to define the "direction" of the Bi-phase/Tach signal.

With a Bi-phase signal, the relationship of the "A" and "B" square waves describes the direction. With a Tach signal, the "A" signal exclusively supplies clock information; the steady state of the "B" signal (high or low) describes the direction. (More information about Bi-phase/Tach signals is detailed later in this chapter.)

***To set the parameter values for a Bi-phase/Tach input signal:***

1. Select Bi-Phase/Tach Input Signal (*bIPH 5I6*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).

2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the four parameter values:

   - Bi-phase: FWD = A leads B (*A LEAd b*) — Here, when the A square wave is ahead of the B square wave, the direction of the Bi-phase signal is understood to be "Forward."
   - Bi-phase: FWD = B leads A (*b LEAd A*) — Here, when the B square wave is ahead of the A square wave, the direction of the Bi-phase signal is understood to be "Forward."
   - Tach: FWD = B is Low (*r–n–d LO* ) — Here, when the B signal is in a "low" state, the rate and direction ("r–n–d") of the Tach signal is understood to be "Forward."

- *Tach: FWD = B is High* (*r–n–d HI*) — Here, when the B signal is in a "high" state, the rate and direction ("r–n–d") of the Tach signal is understood to be "Forward."

3. Use the *Down* and *Up* switches to switch between the parameter values.
4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.


### Video Format/System

Selects the format for both the incoming and outgoing video signals. The two choices are *NTSC* (for North and South America, Japan, and certain other parts of the world) and *PAL* (for most of Europe, Asia, and Africa). Users of SECAM video (for France, Russia, and certain other parts of the world) should select *PAL*.

*Note: Please be sure you have selected the correct format! The Universal Slave Driver will not warn you if you have chosen the wrong one.*

***To select the desired video system:***

1. Select Video System (*VIdEo SY*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).
2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the two parameter values:
   - NTSC (*n75C*); or
   - PAL (*PAL*).
3. Use the *Down* and *Up* switches to switch between the parameter values.
4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

## Regarding the Universal Slave Driver's GPI Trigger I/Os

Configuring and operating the Universal Slave Driver's General Purpose Interface features requires specialized Macintosh software. GPI trigger features are planned for future Pro Tools and AudioVision releases. Neither the Universal Slave Driver's front panel controls nor USD Setup are able to access the GPI features.

## Selecting the Clock Source

As we've just learned, the Universal Slave Driver allows Pro Tools to resolve to external clock references. It does so by varying Pro Tools' sample clock frequency to match changes in the clock reference: As the clock reference speeds up, Pro Tools' sample rate is increased; as the clock reference slows down, Pro Tools' sample rate is decreased.

***To select a clock reference for the Universal Slave Driver:***

1. Push and release the Clock Reference switch to cycle the Universal Slave Driver through its available clock references, which include:
   - Video (depending upon how the Universal Slave Driver is configured, this clock reference may be the *Video Ref In* or the *Video In* connector; for more details, refer to the next section);

- Digital (AES/EBU, Super Clock, or Word Clock; see the "Digital Clock Reference" section later in this chapter to learn how to select the digital clock type);
- Linear Time Code (LTC);
- Pilot Tone;
- Bi-Phase/Tach; or
- Internal/VSO.

2. The active choice will be displayed by one of the Clock Reference LEDs. This choice will also be recalled when the Universal Slave Driver is powered down and powered up again.

And how do you know which clock reference to use? That depends upon the circumstances. Let's examine the options.

### Video

As we've described previously, many post-production facilities use black burst generators to establish house sync, so that all equipment within the facility runs at the same speed. If you want the Universal Slave Driver to clock to house sync, set its front panel clock reference to *Video*. Also be sure to connect a feed from your black burst generator to your Universal Slave Driver's *Video Ref In* connector.

*Note: As with any "shared" video signal, you'll want to ensure that your video feed comes from a properly buffered and distributed source, such as a video distribution amplifier or the black burst output of another device in the house sync chain.*

Once configured, you'll probably want to use this clock reference for most situations, especially those where you're synchronizing Pro Tools to an external VTR, which should also be receiving its clock reference from house sync. However, there may be circumstances when you wish to change this setting, especially when you are transferring audio from one device to another (such as from an analog tape recorder or a DAT recorder to Pro Tools), as described in the coming pages.

#### Which Video Input is Used? (Front Panel Controls Only)

When you select *Video* using the front-panel *Clock Reference* switch, the Universal Slave Driver uses the signal at the *Video Ref In* connector. Typically, this would be a black burst (house sync) signal. Using only the front panel controls, it is not possible to configure the Universal Slave Driver to use the signal at the *Video In* connector. (The USD Setup application does let you choose which one you prefer.)

If you only have a single video source (such as a work print), and you need to insert VITC or a window dub onto the video signal (and the positional reference is not set to *Generate*, i.e. you want to generate VITC referenced to LTC on the work print), you could do the following:

1. Connect the video signal to *Video Ref In*.
2. Run a short BNC jumper cable from the *Video Ref Thru* connector to the *Video In* connector.
3. Connect the *Video Out* signal to the video input of your "destination" VTR or video editing system.

The issue of which video connector is used also matters when choosing a positional reference. For instance, when you select *Generate* using the front-panel Positional Reference switch—and you have selected *Video* as the clock reference—then the time code reference for the generator always comes from the *Video Ref In* connector. However, if you select a positional reference other than *Generate*, then the signal at the *Video In* connector is used. (This applies regardless of whether you are using the front panel controls or the USD Setup application.)

## Managing & Selecting Video Inputs: An Overview of the Video Input Rules

**(for Front Panel Control Only)**

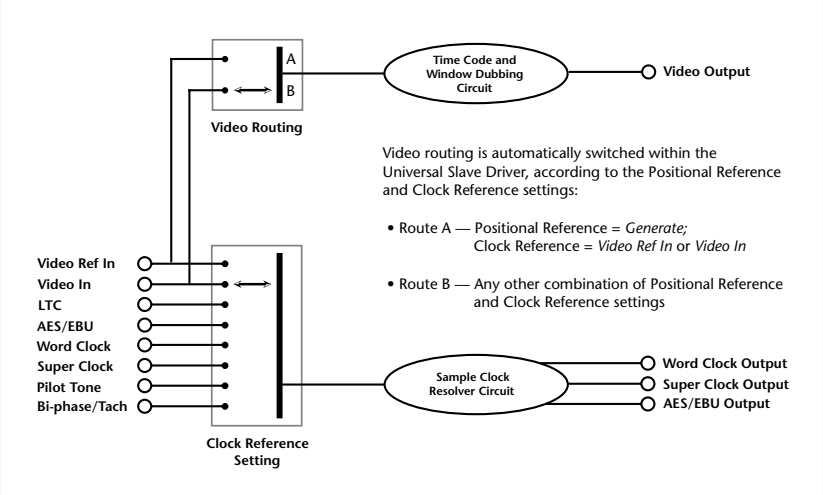
The Universal Slave Driver has two integrated video inputs, which are used for *both* clock reference and positional (time code) reference:

- *Video Ref In* — intended to receive a black burst (house sync) signal, for clock reference purposes.
- *Video In* — intended to receive an "ordinary" video signal, which can supply a clock reference (when synchronizing to the video clock), a positional reference (when synchronizing to VITC), and a video source (onto which regenerated VITC and a window dub can be inserted).

As described in Chapter 3, either video input can be chosen as the clock reference when you are using the Universal Slave Driver in conjunction with the USD Setup application. However, if you are controlling the Universal Slave Driver using only its front panel controls, different rules apply that may also affect which signal is referenced for time code generation, and onto which signal a window dub or VITC may be inserted. Let's review the video input rules covered throughout this chapter:

| | **If the front-panel *Clock Reference* switch is set to:** | **...and the front-panel *Positional Reference* switch is set to:** | **...and this parameter is enabled:** | **...then this video input is used:** |
|---|---|---|---|---|
| **Video Inputs & Generator Reference Rule** | *Video* | *Generate* | n/a | *Video Ref In* |
| | *Video* | Other than *Generate* | n/a | *Video In* |
| **Video Inputs & Window Dubbing Rule** | *Video* | *Generate* | *Window dubbing* | *Video Ref In* |
| | Any combination other than *Video* and *Generate* | | *Window dubbing* | *Video In* |
| **Video Inputs & VITC Video Source Rule** | *Video* | *Generate* | n/a | *Video Ref In* |
| | Any combination other than *Video* and *Generate* | | n/a | *Video In* |

To understand why these rules exist, let's examine how the circuitry works within the Universal Slave Driver:




The clock reference (labelled *Sample Clock Resolver Circuit* in the illustration above) is switchable at all times. You can decide which input signal to use to generate the digital clock signal.

However, when the clock reference is set to *Video,* the positional (time code) reference circuitry (labelled *Time Code and Window Dub Circuit* in the illustration) is not switchable. This is because the positional (time code) reference circuitry is always used to derive time code, whether the Universal Slave Driver is reading incoming time code or generating new time code. Even in *Generate* mode, the Universal Slave Driver needs to use this circuitry to detect the frame edge of the video, in order to generate time code.

Consequently, this is how the *Video* clock reference setting decides which video input to use:

- When the clock reference is set to *Video,* and the positional reference is set to *LTC*, *VITC*, *Auto-Switch LTC/VITC* or *Bi-Phase*, the positional (time code) reference circuitry refers to the *Video In* connector for timing information (labelled *Video Route B* in the illustration.)
- When the clock reference is set to *Video,* and the positional reference is set to *Generate*, the positional (time code) reference circuitry refers to the *Video Ref In* connector for timing information.

Fortunately, if you are using a separate video signals for video reference (black burst) and for program material, these signals will function expectably when connected to the appropriate video inputs: black burst to the *Video Ref In* connector, and program material to the *Video In* connector. All described applications will also function expectably in this situation.

If you only have program material video (without a separate video reference signal) and you want to generate new time code referenced to this signal, you must connect this video source to the *Video Ref In* connector. Additionally, if you also want to overlay a window burn or insert VITC, connect either a video monitor or the recording video deck to the *Video Out* connector.

## Linear Time Code (LTC) • (Clock Reference)

***To resolve the Universal Slave Driver to LTC:***

1. Using the front panel Clock Reference switch, select *LTC* as the clock reference.

Also ensure that you've already connected an LTC source to your Universal Slave Driver's *LTC In* connector.

LTC provides both positional and clock information as part of the time code signal. LTC is the only type of time code that can be recorded on an analog audio tape track as an audible audio signal. Consequently, if you wish to slave Pro Tools to an analog ATR master, then LTC is the way to go. In this situation, you would choose LTC for both the clock reference and positional reference.

LTC can also be recorded onto and played back from one of a VTR's audio tracks. (Many professional VTRs have a dedicated audio track, intended for LTC, called an address or "cue" track.) Sometimes audio post-production engineers receive video work tapes that have been striped only with LTC, and not with VITC.

In this situation, although you would choose LTC as the positional reference, you might prefer to use the video signal (*Video Ref In*) as your clock reference, since it will be much less prone to dropouts, and consequently is more reliable.

Keep in mind that LTC cannot be used as a clock reference when the reference deck is stopped or playing back at a very slow speed. This is because the audio signal is silent (when the source is stopped) or at too low a pitch (when playing slowly). Similarly, at fast wind speeds, the pitch of the LTC may rise beyond the upper playback frequency response of the reference deck (typically 10x or more playback speed), preventing the Universal Slave Driver from being able to resolve to the LTC. More information about reading LTC—and when to use VITC instead of LTC—is detailed later in this chapter.

### Linear *Temperamental* Code?

Because it's an analog audio signal, LTC can sometimes be troublesome. The problems are almost always related to either tape drop outs (tape-shedding), or to level mismatches between the LTC source and the LTC input. As described earlier in this chapter, the Universal Slave Driver's freewheeling feature allows you to compensate for brief time code drop outs. However, if you have serious drop outs, you may not be able to sustain accurate synchronization.

As far as level mismatches go, one thing to ensure is that the LTC is recorded (on the master device) at proper levels—not so high as to be distorted or to cause crosstalk problems on an adjacent audio track, and not so low as to be prone to drop outs or noise interference. After that, you'll want to ensure that the LTC output level is calibrated to match the Universal Slave Driver's LTC input levels. Fortunately, the Universal Slave Driver supports a wide range of LTC input levels (from –24 dBu to +20 dBu), so this shouldn't be a problem.

It is good practice on a 24-track analog tape machine to record time code on Track 24 at a reference level of -10 dBu (or lower), with Track 23 left blank as a "guard" track. This practice avoids crosstalk "bleed" that can occur between the time code track and otherwise adjacent audio tracks. Time code (which is a mid-frequency, alternating pitch square wave) is very sensitive to crosstalk from adjacent tracks, and conversely you don't want audible time code leaking onto your audio tracks. In addition, to avoid problems when recording time code on analog tape machines, the machine should be "free-running." That is, it should be under control of its own internal crystal. If you have transport synchronizers connected to your machine, you should ensure that they are *not* controlling it when recording time code.

## Digital (AES/EBU); Digital (Word Clock); Digital (Super Clock)

A reference clock signal is part of any digital recording system. It is required because whenever digital audio information is mixed together or passed between devices, the playback samples must be aligned with the recording samples. In some cases (such as with AES/EBU or S/PDIF digital interfaces), the clock signal is imbedded in the data stream itself. In other cases, the clock signal is carried as an entirely separate signal from the digital audio sample data.

The Universal Slave Driver is able to resolve to three different types of digital audio clock information: *AES/EBU*, *Word Clock*, and *Super Clock (256x Slave Clock)*. If the Universal Slave Driver is part of your Pro Tools system, and you need to transfer digital audio from an external device to Pro Tools, you'll probably want to resolve your Universal Slave Driver to one of these three digital audio clock types.

### AES/EBU

The AES/EBU audio data stream contains clock information as part of its signal. For instance, when you connect the AES/EBU output of a DAT machine to the AES/EBU input of a Digidesign 888 I/O or 882 I/O Audio Interface and then set Pro Tools to *Digital* sync mode (in Pro Tools' Session Setup window), Pro Tools will resolve automatically to the DAT machine. (This can be done without using the Universal Slave Driver.)

Some professional digital audio products use AES/EBU "null clock" (which is an AES/EBU data stream that contains only clock information and no audio information) as a *system clock reference* source. These systems would then rely upon a single AES/EBU master clock source that is distributed throughout a digital audio facility, in much the same way that house sync is distributed throughout a video facility. If you are connecting the Universal Slave Driver to such a system, you will want to use the Universal Slave Driver's AES/EBU input as the clock reference connection, so that all system components are referenced to the same time base.

In some cases (such as using the Universal Slave Driver as a stand-alone clock resolver or time code generator without a digital audio workstation), you may wish to use an audio DAT machine (or other similar device) as a source of AES/EBU null clock, and resolve your system to this reference source. In this case, the audio sample data in the AES/EBU data stream is stripped off, and only the clock information is used.

***To resolve the Universal Slave Driver to an external device's AES/EBU signal:***

1. Using the front-panel Clock Reference switch, select *Digital* as the clock reference.
2. Using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter), select Digital Reference (*dI6 rEF*):

3. Press the *Set* switch again. The LED Time Code Display will switch to display one of the three parameter values:
   - AES/EBU (*AES-E8U*); or
   - Super Clock (*256 CLOC*); or
   - Word Clock (*I CLOC*).
4. Use the *Down* and *Up* switches to scroll through the parameters.
5. When you have found the AES/EBU (*AES-E8U*) option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

Ensure that you've connected an AES/EBU reference clock signal to the Universal Slave Driver's *AES In* connector. Also, if you are using AudioVision or Pro Tools, be sure to connect the Universal Slave Driver's *Super Clock Out* connector to the *Super Clock In* (or *Slave Clock In*) connector of your 888 I/O or 882 I/O (or other audio interface). The Universal Slave Driver will convert the AES/EBU clock signal to the more precise Super Clock standard used by all Digidesign audio interfaces.

*Note: The Universal Slave Driver's AES In connector only recognizes and uses the clock portion of an incoming AES/EBU audio signal. This is also called "AES digital black," "silent audio" or "null clock" information. Although you can connect a complete AES/EBU audio signal to the Universal Slave Driver, all audio information will be stripped off. Furthermore, audio information will not be passed to the Universal Slave Driver's AES Out connector.*

### Word Clock (1x)

Word Clock is a digital clock reference signal that runs at *1x* sample rate, which is the same rate as the clock signal carried within an AES/EBU or S/PDIF data stream. However, devices that support Word Clock have separate, dedicated BNC-style Word Clock connectors—which carry no audio information of their own. A wide variety of professional audio devices have such Word Clock connectors, including some digital mixing consoles, DASH-standard digital multitrack tape recorders, and Tascam DA-88-compatible 8-track modular, digital multitrack decks.

You should resolve the Universal Slave Driver to Word Clock any time you are transferring digital audio from one of these devices to Pro Tools (assuming the device doesn't have a Super Clock connector).

***To resolve the Universal Slave Driver to a device's Word Clock:***

1. Using the front-panel Clock Reference switch, select *Digital* as the clock reference.
2. Using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter), select Digital Reference (*dI6 rEF*):

3. Press the *Set* switch again. The LED Time Code Display will switch to display one of the three parameter values:
   - AES/EBU (*AES-E8U*); or
   - Super Clock (*256 CLOC*); or
   - Word Clock (*I CLOC*).
4. Use the *Down* and *Up* switches to scroll through the parameters.
5. When you have found the Word Clock (*I CLOC*) option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

Ensure that you've connected the external device's Word Clock output to the Universal Slave Driver's Word Clock In connector. Also be sure you've connected the Universal Slave Driver's *Super Clock Out* to your Digidesign audio interface's *Super Clock In* (or *Super Clock In*). The Universal Slave Driver will convert the Word Clock signal to the more precise Super Clock standard used by all Digidesign audio interfaces.

### Super Clock (256x)

Super Clock (or Slave Clock) is Digidesign's proprietary hi-speed Word Clock which runs at 256x the sample rate. All Digidesign audio interfaces, and several other Digidesign products (including the ADAT Interface, the SMPTE Slave Driver, and the Video Slave Driver), are equipped with Super Clock inputs and outputs.

Super Clock is conceptually the same as Word Clock, in that it's a clock signal that can be passed between devices independently of the audio signal. However, since it runs at 256x sample rate (instead of Word Clock's 1x sample rate), Super Clock is inherently more precise than Word Clock and thus less susceptible to clock signal jitter.

You should resolve the Universal Slave Driver to Super Clock any time you are transferring digital audio from one Digidesign workstation to another, or for those specialized circumstances when you want to resolve the Universal Slave Driver to a SMPTE Slave Driver or Video Slave Driver.

***To resolve the Universal Slave Driver to Super Clock:***

1. Using the front-panel Clock Reference switch, select *Digital* as the clock reference.
2. Using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter), select Digital Reference (*dI6 rEF*):

3. Press the *Set* switch again. The LED Time Code Display will switch to display one of the three parameter values:
   - AES/EBU (*AES-E8U*); or
   - Super Clock (*256 CLOC*); or
   - Word Clock (*I CLOC*).
4. Use the *Down* and *Up* switches to scroll through the parameters.
5. When you have found the Super Clock (*256 CLOC*) option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

Ensure that you've connected the *Super Clock Out* of the reference device (either the audio interface of the "master" Digidesign workstation, or a SMPTE or Video Slave Driver) to the Universal Slave Driver's *Super Clock In* connector. Also be sure you've connected the Universal Slave Driver's *Super Clock Out* to your "slave" Digidesign audio interface's *Super Clock In* (or *Super Clock In*).

### Pilot Tone

The Universal Slave Driver can resolve to an external Pilot Tone signal. This is a relatively specialized application, used by audio post-production engineers for synchronizing to (or transferring audio from) certain types of open-reel audio tape recorders. In general, Pilot Tone is a sine wave reference signal running at the "line frequency" or "mains frequency," meaning the same frequency transmitted by the AC line voltage from the local power utility.

Pilot tone is used on location film productions to establish a common sync reference between a film or video camera with a portable 1/4" analog ATR (such as those made by Nagra or Stellavox). On location, Pilot Tone is derived by clock-referencing the camera to the local AC line frequency (which is 60Hz or 50Hz depending on the country of origin), and this same frequency is then used to clock-reference the ATR. The result is that both the camera and the ATR will run at the same speed.

You can think of Pilot Tone as a kind of inexpensive and readily available "house sync" for location production. Increasingly, it's being replaced by time code, since new-generation film cameras as well as many portable DAT recorders are time code-capable. However, Pilot Tone is still used by a large number of production companies and location sound recordists, which is why the Universal Slave Driver features the ability to use Pilot Tone as a clock reference.

Please note that Pilot Tone contains no *positional* information; it is simply a clock reference. Consequently, sometimes you may encounter an analog 1/4" audio tape that is clock-referenced to Pilot Tone, but which also contains a track of LTC time code. In such situations, you should use the Pilot Tone as the clock reference, and the LTC as a positional reference (especially if the LTC suffers from drop outs).

***To resolve the Universal Slave Driver to Pilot Tone:***

1. Using the front panel Clock Reference switch, select *Pilot* as the clock reference.

Ensure that you've connected a Pilot Tone signal from your clock reference device to the Universal Slave Driver's *Bi-Phase/Tach/GPI/Pilot* port. For detailed wiring information, please see Appendix I.

## Bi-phase/Tach

The Universal Slave Driver is able to resolve to Bi-phase/Tach information for use as a clock reference. As with LTC, Bi-phase/Tach can also be used to provide a positional reference if you provide a reference "start address" via the USD Setup application. (Unlike LTC, the Universal Slave Driver has to interpolate positional information from a Bi-phase/Tach, as described later in this chapter). As with Pilot Tone, resolving to Bi-phase/Tach is a relatively specialized application. It is typically reserved for working with mag machines; 16mm, 35mm, and 70mm projectors; flatbed editing systems; and certain other types of motor-driven film equipment.

Bi-phase (sometimes called "Quadrature Sync") and Tach information are similar—which is why they are generally discussed together in this manual—though they do differ. A Bi-phase signal consists of two square pulse waves, which are generated directly by a device's transport mechanism, and which are 90° out-of-phase with one another. As a Bi-phase-generating device plays, it outputs a steady stream of square wave pulses, which the Universal Slave Driver can use as its clock reference. The Universal Slave Driver can resolve to Bi-phase/Tach information at nearly any speed (including still/paused).

The Universal Slave Driver uses the phase relationship between the two square waves to determine the device's direction (forward or reverse). However, this is relevant only when the Universal Slave Driver is using the Bi-phase signal as a positional reference (as described later in this chapter).

A Tach signal is a variation of Bi-phase. With Tach's two signals, one is used only as the direction indicator, while the other is used as the velocity (or "rate") indicator—which the Universal Slave Driver uses when resolving to Tach as a clock reference. (The differences between Bi-phase and Tach are discussed in greater detail later in this chapter.)

To learn how to resolve the Universal Slave Driver to Bi-phase/Tach, refer to the *"Selecting the Positional Source"* section later in this chapter.

Ensure that you've connected the reference device's Bi-phase/Tach signal to the Universal Slave Driver's *Bi-phase/Tach/GPI/Pilot* connector, and that the cable is wired appropriately, as described in Appendix I. Also, if you wish to use the Universal Slave Driver to resolve Pro Tools to the Bi-phase/Tach clock reference, be sure you've connected the Universal Slave Driver's *Super Clock Out* to your Digidesign audio interface's *Super Clock In* (or *Super Clock In*).

### Internal

In some cases you won't be resolving the Universal Slave Driver to an external clock reference. Rather, you'll be resolving the Universal Slave Driver to its own, crystal-referenced internal clock. In this situation, the Universal Slave Driver will be defining for Pro Tools (and anything else that's receiving its clock reference from the Universal Slave Driver) "how fast we're going."

There are several situations in which you should resolve the Universal Slave Driver to its internal clock, including when you wish to use the Universal Slave Driver as:

- a freestanding time code generator (where clock information and positional information are generated directly by the Universal Slave Driver);
- a time code regenerator (where the external positional reference may be accurate, but the external clock reference may not be); or
- a system (or studio) "master clock" (where you may not have access to a black burst generator, video reference signal, or other such source).

***To resolve the Universal Slave Driver to its internal clock:***

1. Using the front panel Clock Reference switch, select *Internal* as the clock reference.

## Using Pitch Memory (Pitch Hold)

When selected, the Universal Slave Driver will remain at the last known "pitch" (i.e. incoming clock reference speed), even when the tape is stopped. For instance, if LTC from an audio tape recorder (ATR) is used as a clock and positional source, and the ATR is being "varispeeded" fast or slow, Pro Tools' sample rate will adjust to match the ATR's pitch. When deselected, the Universal Slave Driver will revert to the selected sample rate. This can be used to resolve the Universal Slave Driver to "off-speed" free-running LTC.

If Pitch Memory is enabled, and you continue playing back audio in your Pro Tools session after the incoming clock reference has stopped, then Pro Tools will continue to stay "in tune" with the rest of the tracks. In most situations, this is how most people will prefer to work.

If Pitch Memory is disabled and the selected external clock reference is not available, then the Universal Slave Driver will revert to the nominal, selected *internal* sample rate setting.

*User Tip: Disable Pitch Memory Hold if you want to digitally transfer to another device and to ensure the receiving device gets the correct sample rate.*

***To enable or disable the Universal Slave Driver's pitch memory feature:***

1. Using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter), select Pitch Hold (*PICH HLd*):

2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the two parameter values:

   • On (*On*); or

   • Off (*OFF*).

3. Use the *Down* and *Up* switches to switch between the parameter values.

4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until changed.

## Working with Positional References

As you'll recall from Chapter 1, the Universal Slave Driver needs a positional reference to establish the trigger point for playback, or "where we are." This reference always goes hand-in-hand with a clock reference, which establishes "how fast we're going."

(Technically speaking, the Universal Slave Driver's clock resolving and time code reading/generating capabilities are independent. However, from a user's point of view, a clock reference is necessary whenever working with time code—although a positional reference is not necessary for clock resolving.)

Establishing the Universal Slave Driver's positional reference can be an easier decision than establishing the clock reference. This is because it's usually clear what source you'll want to use as a positional reference. For instance, to slave Pro Tools to a video tape, you'll need the video tape's time code (LTC, VITC, or both) as the positional source. At the same time, the choice of clock source might be less obvious, since you might have your choice of house sync (Video Ref), video signal (Video), LTC or more, depending upon your studio and needs.

*Note: For most users, time code (LTC or VITC) is the only positional reference they'll ever use. This applies whether the time code is from an external source, or whether it's generated internally by the Universal Slave Driver. Since, the Universal Slave Driver can interpolate a positional reference based on an incoming Bi-phase/Tach signal, "time code" and "positional reference" are not always directly synonymous. Even so, this User's Guide treats these two terms as interchangeable, unless referring specifically to Bi-phase/Tach.*

### About Time Code & DAWs: Positional Reference (Trigger Start Point) + Clock Reference = Sync

You can resolve the Universal Slave Driver to an external clock reference without locking it a positional reference. For instance, you can use the Universal Slave Driver to resolve Pro Tools' clock to house sync, without synchronizing Pro Tools to external time code.

However, whenever you lock the Universal Slave Driver to a positional reference, you'll need resolve it to a clock reference (even if you use the Universal Slave Driver's internal clock). This is because Pro Tools and other digital audio workstations require a clock reference—in addition to time code—in order to maintain synchronization over time.

Let's explore this a little further using a typical sync situation, with Pro Tools being slaved to a video tape recorder, using a Universal Slave Driver:

1. When you start the videotape, time code (either LTC or VITC) is read off the tape and is routed to the Universal Slave Driver.

2. Next, using a MIDI interface, the Universal Slave Driver sends Pro Tools the address of the first instance of time code it receives. (An upcoming release of Pro Tools software will be able to

receive Universal Driver information without a MIDI interface.) At the same time, based upon whatever clock reference you've chosen, the Universal Slave Driver sends Super Clock information to Pro Tools. (With just a simple system, without house sync, you would probably use *Video In* as the Universal Slave Driver's clock reference.)

3. In turn, Pro Tools takes the first time code address it receives, and calculates the point (sample number) in the session that corresponds to the address. (Even though you can work with Pro Tools using any standard time code format, it actually "thinks" in terms of sample numbers—which means that it translates the time code address to an exact sample number).

4. Assuming that the time code address corresponds to a sample number that is within the Pro Tools session, Pro Tools uses that address to start playback at the "trigger point." That is, it converts the time code address to a sample number within the session, and begins playing back from that point.

5. Once playback has been initiated, Pro Tools now turns to the Universal Slave Driver's clock reference (sent as Super Clock to Pro Tools). This clock reference now "drives" Pro Tools playback, so that if the videotape were to undergo minor speed deviations during playback, Pro Tools would stay perfectly synchronized.

6. At this point, if the videotape is stopped, rewound, and started again, the entire process is repeated, based upon a newly calculated trigger point.

In this way, Pro Tools uses both time code (positional) and clock references to maintain synchronization—and the Universal Slave Driver delivers both.

## Selecting the Positional Source

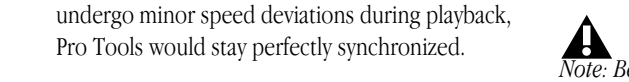
As we've just learned, the Universal Slave Driver uses positional information to send Pro Tools a "trigger start" time code address; thereafter, Pro Tools uses Super Clock information to maintain synchronization.

***To select a positional reference for the Universal Slave Driver:***

1. Push and release the Clock Reference switch to cycle the Universal Slave Driver through its available clock references, which include:

   - Linear Time Code (labelled *LTC*);
   - Vertical Interval Time Code (labelled *VITC*);
   - Auto-Switch LTC/VITC (labelled with a line joining the *LTC* and *VITC* Positional Reference LEDs, and set when both LEDs are illuminated);
   - Bi-phase/Tach (labelled *Bi-phase*); or
   - *Generate* — for generating time code internally (with the Universal Slave Driver as the master time code source).

2. The active choice will be displayed by one of the Positional Reference LEDs. This choice will also be recalled when the Universal Slave Driver is powered down and powered up again.



*Note: Be sure to select the appropriate frame rates whenever you use LTC or VITC as your positional reference!*

Let's review the positional reference options in detail.

### Linear Time Code (LTC) • (Positional Reference)

As described earlier, since LTC is recorded and played back as an analog audio signal, LTC can be striped onto any ATR's or VTR's audio track. (Professional VTRs typically have an address or "cue" track, intended for LTC.) As also described, if you are working with a standard audio tape, you'll almost certainly be working with LTC; if you're working with a videotape, you may be able to work with either LTC or VITC, or both.

LTC can function simultaneously as a *positional* reference and a *clock* reference. As a positional reference, LTC has several benefits and drawbacks when compared to VITC:

- LTC is usually striped before the music and other audio tracks (on an ATR), or at the same time as the video signal (on a VTR). If necessary, LTC can be striped independently of other audio tracks or the video picture. This can be helpful if the time code needs to be rerecorded over the existing LTC track or, in the case of a multitrack tape machine, on another track.
- LTC can be read at faster winding rates than VITC (up until the LTC's pitch exceeds the upper high-end frequency response of the ATR or VTR).
- Unlike VITC, LTC cannot be read when the deck is paused or "crawling" slowly. When working with Pro Tools, this means that LTC cannot be used for Auto-Spotting regions when jogging the videotape to particular video frames.
- Use of LTC is universal throughout the audio post-production community. The use of VITC is not as common in the audio community, although it is more common in video editing applications. Many audio professionals using DAWs are not aware of the benefits of working with VITC, especially for still-frame spotting. In addition, VITC must be recorded at the same time as the video signal, and cannot be dubbed on later (unless a copy of the original video element is made). As a result, you may find it is more difficult to get work prints containing VITC from post-production houses. However, the benefits of using both forms of time code are clear, and it's well worth trying to get elements that contain both standards for maximum flexibility and speed when working.
- LTC can be more prone than VITC to tape-shedding problems and subsequent time code dropouts. (This is why the Universal Slave Driver offers a freewheeling feature, as detailed earlier in this chapter.)

***To select Linear Time Code (LTC) as the Universal Slave Driver's positional reference:***

1. Using the front panel Positional Reference switch, select *LTC* as the positional reference.

Ensure that you've selected the appropriate clock reference, sample rate, frame rate, and freewheel duration. Also ensure that your LTC signal is routed properly to the Universal Slave Driver's *LTC In* connector.

### Vertical Interval Time Code (VITC)

VITC is a commonly used positional reference in professional audio post-production. Since VITC is time code information that is embedded as part of the video signal, you can obtain a time code reading whenever you can see a video picture. This offers several benefits:

- VITC can be read when the VTR is paused or crawling slowly. When working with Pro Tools, this means that VITC can be used for Auto-Spotting regions to particular video frames.
- VITC is less prone to tape drop outs, and in this sense, is inherently more reliable than LTC.

- VITC can be embedded into any video signal, including digital video signals (tape or nonlinear), without requiring an extra audio track to carry time code.

*Note: In order for VITC to be read when a videotape is paused, the picture must remain visible. However, to save wear-and-tear on video heads, after a few minutes of still/pause mode, many VTRs will automatically drop into stop mode—which means the tape will be disengaged from the video heads, and VITC can no longer be read off the tape. To continue reading VITC, you may need to reengage still/pause, or press play and re-shuttle the tape to the desired frame. This problem highlights a reason why, whenever possible, you might want to use Video Ref In as your clock reference instead of Video In. Even when the video picture disappears, the Universal Slave Driver will remain resolved to the black burst signal at the Video Ref In connector, this ensuring a constant supply of resolved Super Clock information to your Pro Tools system (or other compatible DAW).*

***To select VITC as the Universal Slave Driver's positional reference:***

1. Using the front panel Positional Reference switch, select *VITC* as the positional reference.

Ensure that you've selected the appropriate clock reference, sample rate, frame rate, and freewheel duration. Also ensure that your VITC-striped video signal is routed properly to the Universal Slave Driver's *Video In* connector (not the *Video Ref In* connector). If you wish to use a black burst signal as the clock reference (instead of the video signal), then be sure to connect it to the *Video Ref In* connector.

### Auto-Switch LTC/VITC

If you wish, you can configure the Universal Slave Driver to switch automatically between LTC and VITC, depending upon which is delivering the best signal at any given time. This is a very flexible configuration, and is the USD's default setup mode when powered on (unless changed).

As described earlier, when a VTR is paused, it's impossible to read LTC from the videotape. Consequently, when using only LTC, there's no way you can use Pro Tools to perform Auto-Spotting of regions when the tape is paused. However, VITC continues to be read (whenever the picture remains visible), so it can be used as a positional reference when the VTR is paused. On the other hand, VITC cannot be read at fast winding speeds (except by some specialized, high-end VTRs), and LTC can be read at fast winding speeds, as long as its signal remains within the high-end frequency response of the ATR or VTR.

With its auto-switching option, the Universal Slave Driver follows these rules for deciding which time code to read:

- If only LTC is currently readable (for example, if the tape speed is too high to read VITC, or if VITC is not connected), then the Universal Slave Driver will switch to LTC as its positional reference.
- If only VITC is currently available (for example, if the tape is paused, and therefore the videotape deck cannot output LTC, or LTC is not connected), then the Universal Slave Driver will switch to VITC as its positional reference.
- If *both* LTC and VITC are available, the Universal Slave Driver chooses which one to use based on the speed of playback. The switch-over point is approximately 75% of full 1x playback speed. Above 75% playback speed, LTC is favored; below 75% speed, VITC is favored.

- If a dropout should occur, the Universal Slave Driver waits until the freewheel duration has expired before attempting to switch over to the opposite source. If, at that time, neither source is available, the Universal Slave Driver will stop reading time code.

***To have the Universal Slave Driver switch automatically between LTC and VITC as its positional reference:***

1. Using the front panel Positional Reference switch, select *Auto-Switch LTC/VITC* (labelled with a line joining the *LTC* and *VITC* Positional Reference LEDs, and set when both LEDs are illuminated).

Ensure that you've selected the appropriate clock reference, sample rate, frame rate, and freewheel duration. Also ensure that:

- your LTC signal is routed properly to the Universal Slave Driver's *LTC In* connector;
- your VITC-striped video signal is routed properly to the Universal Slave Driver's *Video In* connector (not the *Video Ref In* connector); and
- both your LTC and VITC (and/or your on-screen video "window burn," if any) have been striped with identical time code numbers.

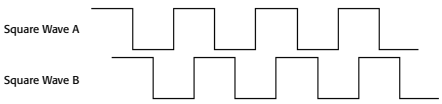
*Note: Some brands of older 3/4" U-matic VTRs have time code address tracks which have a fixed offset of several frames when compared with the audio tracks (which exactly match the video in terms of time). This could cause problems when using your Universal Slave Driver's LTC/VITC auto-switching capabilities. You can verify proper synchronization between your time code and address tracks by comparing the Universal Slave Driver's time code reader numbers, when "looking" at the various tracks, to an on-screen "window burn," on the video work print supplied by the post-production house. Alternatively, you can create your own window burn if you create a dub copy with the Universal Slave Driver, using its time code generation (LTC or VITC) and window burn generation capabilities.*

## Bi-phase/Tach

In most cases, post-production professionals working with film will want to utilize the Universal Slave Driver's ability to lock to a Bi-phase/Tach signal as a positional reference. If you use a mag recorder or other similar film transport, then using a Bi-phase/Tach signal may provide the best (or only) way to slave Pro Tools to the reference.

Strictly speaking, Bi-phase/Tach signals are clock reference signals, and do not contain positional information of their own. However, they do contain enough information for the Universal Slave Driver to calculate positional information. Here's how this works:

Bi-phase/Tach signals use two square waves to generate pulses that can function as a clock reference. The two square waves are 90° out-of-phase, in a pattern that resembles this:




With a Bi-phase signal, the Universal Slave Driver can deduce the direction (forward or reverse) of the signal based upon which wave is read "high" relative to the other.

For instance, with some film equipment, when the device is running forward, it will generate a Bi-phase signal where the "A" wave leads the "B" wave—that is, where the A wave peaks before the B wave peaks. When the device is in reverse, the B wave will lead the A wave. However, some film equipment works in the opposite manner, which is why the Universal Slave

Driver lets you choose the appropriate input signal (*Fwd = A leads B*, or *Fwd = B leads A*), as detailed shortly.

Calculating the direction of a Tach signal is slightly different. As you may recall, Tach also uses two signals. The "A" signal is a square wave that provides clock information; the B signal is in a steady state (high, or low) that indicates the direction. Unfortunately, not all Tach-generating equipment uses the B signal in the same way. Fortunately, the Universal Slave Driver also lets you choose the appropriate method (*Tach: Fwd = B is Low*, or *Tach: Fwd = B is High*).

Now we understand how the Universal Slave Driver can use a Bi-phase/Tach signal to deduce the direction, and how it also uses the signal as a clock reference.

***To select Bi-phase/Tach as the Universal Slave Driver's clock reference:***

1. Using the front panel Clock Reference switch, select *Bi-phase/Tach* as the positional reference.

Typically, when you use Bi-phase/Tach as the clock reference, you'll also be using it as the positional reference.

***To select Bi-phase/Tach as the Universal Slave Driver's positional reference:***

1. Using the front panel Positional Reference switch, select *Bi-phase* as the positional reference.

Ensure that you've routed the Bi-phase/Tach signal to the Universal Slave Driver's *Bi-phase/Tach/GPI/Port* connector, and that it's wired properly, as described in Appendix I.

At this point, the Universal Slave Driver needs to know the direction of the Bi-phase/Tach signal. Given the starting frame and the direction, the Universal Slave Driver can interpolate and accurately calculate location, just as if the Bi-phase/Tach signal were time code.

***To define the direction for a Bi-phase/Tach input signal:***

1. Using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter), select Bi-Phase/Tach Input Signal (*bIPH 5I6*):

2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the four parameter values:

   - Bi-phase: FWD = A leads B (*A LEAd b*) — Here, when the A square wave is ahead of the B square wave, the direction of the Bi-phase signal is understood to be "Forward."
   - Bi-phase: FWD = B leads A (*b LEAd A*) — Here, when the B square wave is ahead of the A square wave, the direction of the Bi-phase signal is understood to be "Forward."
   - Tach: FWD = B is Low (*r–n–d LO* ) — Here, when the B signal is in a "low" state, the rate and direction ("r–n–d") of the Tach signal is understood to be "Forward."
   - *Tach: FWD = B is High* (*r–n–d HI* ) — Here, when the B signal is in a "high" state, the rate and direction ("r–n–d") of the Tach signal is understood to be "Forward."

3. Use the *Down* and *Up* switches to switch between the parameter values.

4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

There are several different standards for the number of pulses-per-frame outputted by Bi-phase or Tach devices. Using USD Setup's *Pulse Per Frame* setting, you can set the Universal Slave Driver to operate from 2 to 254 pulses per frame. The setting should match the PPF rate of the external device's Bi-phase/Tach encoder.

***To set the pulses per frame value for a Bi-phase/Tach signal:***

1. Using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter), select Bi-Phase/Tach Pulses Per Frame (*bIPH PPF*):

2. Press the *Set* switch again. The LED Time Code Display will switch to display the current parameter values, from 2 to 255 pulses per frame. The readout will look something like this:

*0002*

3. Use the *Down* and *Up* switches to scroll through the parameter values. Pressing and releasing the switches will change the value by just one pulse per frame. Pressing and holding the switches will scroll at a faster speed.

4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

However, in order to use the Bi-phase/Tach signal as a positional reference, the Universal Slave Driver also needs to know the starting time code address of the frame of the first clock signal. Since the Bi-phase/Tach doesn't contain this information, we need to "tell" the Universal Slave Driver what is the starting frame.

To select the starting frame for a Bi-phase/Tach signal, use the Set Gen (*SE7 6En*) parameter as described in the *"Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter. Setting a preset start time is necessary because Bi-phase/Tach has no positional information of its own. However, given a preset start time code address, the Universal Slave Driver can calculate and generate time code based upon the direction of the Bi-phase/Tach pulses. Once set, the Universal Slave Driver will begin to generate time code as soon as it detects incoming

*User Tip: If you are set to use Bi-phase/Tach for the positional reference, and the Universal Slave Driver is generating time code, the Up and Down switches can be used to adjust the time code value up and down. This can be useful for "trimming" you time code value, should you notice a sync discrepancy.*

### Generate

In this mode, the Universal Slave Driver generates its own positional reference. This feature is detailed in the next section.

## Generating & Regenerating Time Code & Clock Information

The Universal Slave Driver outputs time code and clock information in one of two modes: Read/Regeneration Mode and the Generator Preset Mode. In either mode, the Universal Slave Driver simultaneously regenerates or generates time code (LTC, VITC, and MTC), plus a variety of clocks (Super Clock, Word Clock, and AES/EBU).

Let's take a closer look at these two modes.

### Read/Regeneration Mode

In this mode, the Universal Slave Driver regenerates time code based upon external positional reference information (LTC or VITC time code, or a Bi-phase/Tach signal). Subject to certain conditions, three types of time code (LTC, VITC, and MTC) are simultaneously regenerated from the selected positional reference.

In order for the Universal Slave Driver to regenerate LTC, the external positional reference must be moving at normal, 1x forward speed (± 10%). In order to regenerate VITC, the positional reference must be LTC or Bi-phase/Tach, at any readable speed, forward or reverse.

*Note: The Universal Slave Driver can regenerate VITC only when the positional reference is set to LTC or Bi-phase/Tach, or internally to Generate. The Universal Slave Driver will not regenerate VITC if the positional reference is VITC.*

In order for the Universal Slave Driver to regenerate MTC, the external positional reference must be moving at normal, 1x forward speed (± 10%). Outside of this speed range and direction, MTC is generated in bursts every 200 milliseconds; this is done to allow MTC-slaved devices to read VITC or Bi-phase properly in either direction, and at any readable velocity down to zero. In any case, the Universal Slave Driver begins regenerating MTC as soon as it detects a valid signal from its incoming positional reference.

If the positional reference is LTC or VITC, the Universal Slave Driver will regenerate time code addresses that are identical to the incoming time code addresses (with a feature that allows up to 40 frames of LTC or VITC to be freewheeled). If the positional reference is a Bi-phase/Tach signal, the Universal Slave Driver will generate time code addresses starting at the Bi-phase preset start time, as described in the last section in this chapter.

### Generator Preset Mode (Positional Reference = Generate)

In this mode, the Universal Slave Driver generates time code internally, with a start time is based upon the Generator Preset Time (as detailed in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter). The Positional Reference switch is set to *Generate*. Using the Universal Slave Driver's front panel controls (or USD Setup), you can start, stop, resume, and reset time code generation.

When generating time code in Generator Preset Mode, the Universal Slave Driver's time code generator is resolved (locked) to one of two possible sources, based upon the following rule:

#### Generator Reference Rule

- If the front-panel *Clock Reference* switch is set to *Internal*, *LTC*, *Pilot Tone*, *Bi-Phase/Tach*, or *Digital* (AES/EBU, Super Clock, or Word Clock), then the time code generator will lock to the *Video In* input.
- If the front-panel *Clock Reference* is set to *Video*, then the time code generator will lock to the *Video Ref In* input.

## LTC Generation/Regeneration

As described earlier, the Universal Slave Driver will regenerate LTC whenever the external positional reference is moving at normal, 1x forward speed (± 10%).

***To regenerate LTC based upon an external positional reference:***

1. Ensure that the Universal Slave Driver's LTC output is connected to an appropriate audio input or time code input of a "destination" device (the device onto which you wish to record LTC).
2. Next, set the level of the LTC analog signal. To do this, select the desired level (–24 dBu to +9 dBu) from the USD Setup's *LTC Output Level* pop-up menu. If you're in doubt, set the signal to –10 dBu.
3. Set the input level of the destination device to record LTC at an appropriate level. Certain consumer-grade devices may require a relatively low level, to minimize the chance of crosstalk onto other audio tracks. If the incoming signal remains too "hot," then reduce the Universal Slave Driver's LTC output level, as described in Step 2.
4. Using the Universal Slave Driver's *Positional Reference* switch, select the desired external positional reference (any choice except *Generate*).
5. The Universal Slave Driver will now begin regenerating LTC as soon as it receives a valid positional reference signal.

The Universal Slave Driver can also generate LTC in Generator Preset Mode—using its integral time code generating feature (Positional Reference = *Generate*)—allowing the Universal Slave Driver to function as a complete stand-alone time code generator. In this mode, you can use either an external clock reference, or the Universal Slave Driver's internal crystal as a clock reference. When generating LTC, you can set a start time to be anything you desire. Refer to the *Generator Reference Rule*, above, when choosing to which clock source the generator will resolve (lock).

***To generate LTC internally:***

1. Ensure that the Universal Slave Driver's LTC output is connected to an appropriate audio input or time code input of a "destination" device (the device onto which you wish to record LTC).
2. Next, set the level of the LTC analog signal. To do this, select the desired level (–24 dBu to +9 dBu) from the USD Setup's *LTC Output Level* pop-up menu. If you're in doubt, set the signal to –10 dBu.
3. Set the input level of the destination device to record LTC at an appropriate level. Certain consumer-grade devices may require a relatively low level, to minimize the chance of crosstalk onto other audio tracks. If the incoming signal remains too "hot," then reduce the Universal Slave Driver's LTC output level, as described in Step 2.
4. Using the Universal Slave Driver's *Positional Reference* switch, select *Generate*.
5. Configure the desired time code start, in hours:minutes:seconds:frames—as detailed in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter.

6. You are now ready to begin generating LTC. Typically, at this point you would arm the destination ATR or VTR to record LTC on one of its audio tracks or time code track.

7. If you've selected *Internal* as the clock reference, all you need to do is press and release the *Run/Stop • Clear* switch. If you've selected an external clock reference, however, that reference will need to be applied to the Universal Slave Driver before you can press and release the *Run/Stop • Clear* switch.

8. When you have finished generating the desired length of LTC, press and release the *Run/Stop • Clear* switch again to stop generating.

## More about VITC Generation/Regeneration

Working with VITC is considerably more complicated than working with LTC. One important difference is that whereas the Universal Slave Driver will output LTC using any clock or positional reference, your choices are more limited when it comes to outputting VITC—due to the very nature of VITC.

Furthermore, when you use the Universal Slave Driver to regenerate VITC (based upon an external positional reference)—or to generate VITC (based upon its internal, crystal time code generator)—you'll be inserting VITC into an existing video signal.

For instance, a common situation would be where you wish to insert VITC while transferring video from a "source" VTR (or a nonlinear video editing system) to a "destination" VTR (or a nonlinear video editing system). With this arrangement, you would connect the video source signal to one of the Universal Slave Driver's video input connectors. The choice of which video input connector to use depends on the following rule:

**VITC Video Source Rule**

- When the Universal Slave Driver is in Generator Preset Mode (Positional Reference = *Generate*)—and the *Clock Reference* switch is set to *Video*—then VITC will be inserted onto the video signal present at the *Video Ref In* connector.
- In all other permutations of the *Positional Reference* and *Clock Reference* switches, VITC will be inserted onto the video signal present at the *Video In* connector.

Next, once you've configured your video source, you'll want to route the Universal Slave Driver's *Video Out* signal to the destination VTR (or other device). In this way, the Universal Slave Driver will be able to stripe the second VTR's videotape with VITC. (At the same, you might also wish to insert a window dub, as described later in this chapter.) Please be aware that since the Universal Slave Driver has to be inserted into "the loop" between two video devices, there's no way for the Universal Slave Driver to insert VITC into a video signal if you only have a single video device.

*Note: Unlike LTC, the Universal Slave Driver can regenerate VITC with both forward and reverse time code addresses.*

In order for the Universal Slave Driver to regenerate VITC based upon an external positional reference, you'll need to select both a clock reference (see above for the *VITC Video Source* rule) and a positional reference.

***To regenerate VITC based upon an external positional reference:***

1. Ensure that the Universal Slave Driver is connected in-line with a video source and video destination, as described just above.

2. Next, enable the Universal Slave Driver to insert VITC. Select VITC Insertion (*VI7C In5*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).

2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the two parameter values (*On* or *OFF*).

3. Use the *Down* and *Up* switches to switch between the parameter values. When you have chosen the *On* setting, press *Set*. The LED Time Code Display will return to showing time code numbers.

4. Ensure that you have selected the appropriate format (*NTSC* or *PAL*; as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).

5. Now you'll select onto which line pair you'll be generating VITC. Select VITC Generate Lines (*6En LInE*), using the *Set*, *Down*, and *Up* switches. Press the *Set* switch again. The LED Time Code Display will switch to display the available line pairs ranging from *10/12* through *20/22.* Both the Universal Slave Driver and USD Setup default to use line pair *14/16*, which is also the SMPTE-recommended setting.

6. Use the *Down* and *Up* switches to scroll through the parameter values. When you have chosen your desired line pair, press *Set*. The LED Time Code Display will return to showing time code numbers.

7. Select any desired clock reference, using the *Clock Reference* switch (don't forget the *VITC Video Source Rule*, so that you know onto which video input signal the VITC will be applied).

8. Select one of the following positional references, using the *Positional Reference* switch:

   - *LTC*; or
   - *Bi-phase/Tach* .

*Note: Because it is impossible for the Universal Slave Driver to read from and write to the same line in a video picture, you cannot use an external VITC source as a positional reference to regenerate new VITC. Furthermore, if you wish to use LTC as a positional source, do not select Auto-Switch LTC/VITC.*

9. The Universal Slave Driver will now regenerate VITC and insert it onto the video signal (as soon as it receives a valid positional reference signal).

The Universal Slave Driver can also generate VITC "internally," (Positional Reference switch = *Generate*), using its integral time code generating feature. In this mode, you can use either an external clock reference, or the Universal Slave Driver's internal crystal as a clock reference. By generating VITC internally, you can set a start time to anything you desire.

*Note: When generating VITC internally, keep in mind that if the insertion is not timed based upon a "upstream" video reference, you may encounter repeated or skipped VITC frames (see VITC Timing Rule, discussed later). Also, review the VITC Video Source Rule, mentioned earlier.*

***To generate VITC internally:***

1. Ensure that the Universal Slave Driver is connected in-line with a video source and video destination, as described just above.

2. Next, enable the Universal Slave Driver to insert VITC. Select VITC Insertion (*VI7C In5*), using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).

2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the two parameter values (*On* or *OFF*).

3. Use the *Down* and *Up* switches to switch between the parameter values. When you have chosen the *On* setting, press *Set*. The LED Time Code Display will return to showing time code numbers.

4. Ensure that you have selected the appropriate format (*NTSC* or *PAL*; as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter).

5. Now you'll select onto which line pair you'll be generating VITC. Select VITC Generate Lines (*6En LInE*), using the *Set*, *Down*, and *Up* switches. Press the *Set* switch again. The LED Time Code Display will switch to display the available line pairs ranging from *10/12* through *20/22.* Both the Universal Slave Driver and USD Setup default to use line pair *14/16*, which is also the SMPTE-recommended setting.

6. Use the *Down* and *Up* switches to scroll through the parameter values. When you have chosen your desired line pair, press *Set*. The LED Time Code Display will return to showing time code numbers.

7. Select any desired clock reference, using the *Clock Reference* switch (don't forget the *VITC Video Source Rule*, so that you know onto which video input signal the VITC will be applied).

8. Next, you'll configure the Universal Slave Driver to generate time code internally, without using an external positional reference. Using the Positional Reference switch, select *Generate*.

9. Set the time code start time, as detailed in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter.

10. You are now ready to begin generating VITC, which will be inserted into the video signal. Typically, at this point you would arm the destination VTR to record video, so that VITC can be inserted into the video signal, and be recorded on the destination videotape.

11. Make sure that your chosen clock reference is actually present and running, then click the *Run* button. The time code addresses will begin to increment smoothly.

12. Press and release the *Run/Stop • Clear* switch when you want to pause or stop the generating process.

*Note: Regardless of whether you are generating or regenerating, an active video signal will need to be present at one of the Universal Slave Driver's video inputs (again, see VITC Video Source Rule, mentioned earlier). Remember, if the source of your video is a VTR/VCR, and if the heads disengage from the source video tape during an extended pause, you'll need to press pause again, or start the video tape, in order to generate VITC. And of course, the video signal will need to be playing in order to actually record VITC into the video signal.*

### VITC Timing Rule

There's another important rule for you to consider whenever you are generating or regenerating VITC. It may seem esoteric, but it is important for successful VITC insertion:

#### VITC Timing Rule

- Inserted VITC—regardless of whether it is being regenerated (derived from an external positional reference such as LTC), or being generated (Generator Preset Mode)—should be *monotonic*.

By "monotonic," we mean that the VITC should be smoothly ascending or descending, with no repeated or skipped frame addresses. In order to achieve monotonicity, the external positional reference (while regenerating) or the clock source (in Generator Preset Mode) must be synchronous with the video signal onto which the VITC is being inserted.

As an example, if you are using LTC as a positional reference from, say, a 3/4-inch U-Matic VTR, then that VTR should be referenced to the same video signal that you are applying to the Universal Slave Driver. As another example, in Generator Preset Mode (Positional Reference = *Generate*), a clock reference of Internal is not a good choice, simply because the Universal Slave Driver's internal crystal runs asynchronously with respect to the supplied video signal, and thus repeated or skipped frame addresses are sure to eventually occur.

## MTC Generation/Regeneration

MIDI Time Code is a serial digital signal. In many ways, you can think of it as an inaudible type of LTC, that can be used by various MIDI devices. Similarly to LTC, MTC also conveys time addresses in terms of hours:minutes:seconds:frames.

MTC outputs from the Universal Slave Driver's *MTC Out* connector, which is a standard DIN-style 5-pin female MIDI connector. To use MTC, you'll need to connect *MTC Out* to a MIDI In connector of a device that can recognize and use MTC. Typically, this would be an outboard "hardware" sequencer, a synthesizer or sampler keyboard with a built-in sequencer, or a drum machine. Alternatively, it could be a MIDI interface used in conjunction with Mac or PC sequencing software.

MTC is output from the Universal Slave Driver at all times that LTC is output. This means that regardless of whether LTC is being output in Generator Preset Mode (Positional Reference = *Generate*) or while regenerating (Positional Reference = *LTC*, *VITC*, *Auto-Switch LTC/VITC*, or *Bi-Phase/Tach*), MTC is simultaneously output in parallel with that LTC.

However, it is possible for the Universal Slave Driver to output MTC without outputting LTC: Should the Universal Slave Driver stop outputting LTC (for any reason), it will continue to output MTC in "bursts" of one frame every 200 milliseconds when the Universal Slave Driver is reading VITC. The Universal Slave Driver does this so that any connected MIDI-reading device can be continuously updated as to the position of VITC or Bi-phase (either of which might be operating at slow or still speeds). Thus, you can still use a connected MIDI device for Auto-Spotting from VITC or Bi-phase.

## Generating a Window Dub

The Universal Slave Driver offers the feature of window dubbing, which superimposes onto a video signal a small, visible area—called a *window dub*, or *window burn*, or *time code window*—that displays time code in hours:minutes:seconds:frames.

Here's what a window dub looks like once it's been "burned" onto a video image:


*Video image with window dub*

A window dub can be very helpful for anyone involved in audio-for-picture, since it gives you an instant, visual cue as to where you are in time.

When working with Pro Tools, for instance, you can use a window dub to help you locate a particular video frame that has been "cued" by the director for a particular sound effect. Or, if you're in Pro Tools' Spot mode, and you want to spot a region to the same video frame at which you've paused your videotape, you can simply type in the time code reading you see in the window dub. (This is especially useful if your only time code reference from the tape is LTC—since in order to do Auto-Spotting within Pro Tools when the videotape is paused, you need VITC.)

With the Universal Slave Driver, the window dub's time code addresses are derived from the positional reference. In other words, if you've chosen an external reference, such as LTC or VITC, the window dub's readings reflect those of the incoming time code; if you've chosen to generate time code internally (i.e., your positional reference is set to *Generate*), then the window dub will start its address from whatever you've set as the Generator/Bi-phase Preset start time.



*Note: In order to use a window dub properly, its addresses will need to be accurate. Consequently, assuming you want the window dub's readings to match the actual LTC or VITC time code that's associated with the video image, be sure you choose the correct positional reference. For instance, it's quite common to stripe a video signal simultaneously with VITC and a window dub. In this case, since VITC cannot be regenerated from a VITC positional reference, you'll want to ensure that you're using LTC (or Bi-Phase/Tach) as your positional reference.*

As with regenerating VITC, the Universal Slave Driver can only burn a window dub onto an existing video signal. This means that a video "source" signal (from a VTR, nonlinear editing system, or other video device) will need to be present at one of the Universal Slave Driver's video input connectors (*Video In* or *Video Ref In*). When generating a window dub, the two rules mentioned in the VITC section (the *VITC Timing Rule* and the *VITC Video Source Rule*) also apply—as does the *Video Inputs & Window Dubbing Rule,* described in the *"Managing & Selecting Video Inputs: An Overview of the Video Input Rules"* section earlier in this chapter. Finally, a signal from the Universal Slave Driver's *Video Out* connector will need to be routed to a video "destination" (such as another VTR or nonlinear editing system).

To burn a window dub onto a video signal, first enable the Universal Slave Driver to perform window dubbing.

***To enable or disable the Universal Slave Driver's window dubbing feature:***

1. Using the *Set*, *Down*, and *Up* switches (as described in the *"Selecting Parameter Names and Values Using the Generator/Parameter Controls"* section earlier in this chapter), select Burn Enabled (*burn EnA*):


2. Press the *Set* switch again. The LED Time Code Display will switch to display one of the two parameter values:
   - On (*On*); or
   - Off (*OFF*).
3. Use the *Down* and *Up* switches to switch between the parameter values.
4. When you have chosen your desired option, press *Set*. The LED Time Code Display will return to showing time code numbers. The Universal Slave Driver will retain the setting, even when the unit is powered off and on again, until it is changed.

*Note: Only the USD Setup application allows you to adjust the window dub's size, vertical position, horizontal position, and color. These parameters cannot be adjusted from the Universal Slave Driver's front-panel controls. Assuming these parameters have not been adjusted otherwise using USD Setup, then the Universal Slave Driver will default to the following:*

- *Size: Large*
- *Vertical Position: 20% from bottom*
- *Horizontal Position: Center*
- *Color: White numerals on a black background.*

Also ensure that you've made all the proper video connections, and that you've selected the desired positional reference.

After you have completed these steps, you'll burn a window dub—with time code addresses based upon the selected positional reference—onto any video signal that's passing through the Universal Slave Driver.

*Note: Remember, if you need to change the "look" of the window dub—in terms of size, vertical position, horizontal position, and color—you'll need to use the USD Setup application. For more details, please refer to Chapter 3.*

## Conclusion

This concludes the chapter on operating the Universal Slave Driver using its front panel controls.

# Troubleshooting

# Troubleshooting

Getting SMPTE synchronization to work properly can seem like a formidable task at times. The following suggestions may help you troubleshoot and solve common problems.

### 1. Stripe SMPTE Before You Record

All tape machines in your setup (both audio and video) *absolutely must* be striped with SMPTE Time Code *before* any audio is recorded onto them or to Pro Tools or AudioVision systems. If you don't, your system may *seem* to work, but synchronization will never properly occur. The machines and Pro Tools or AudioVision will drift farther and farther apart the longer they run.

The same problem occurs when audio is recorded into Pro Tools or AudioVision without a resolved SMPTE source (if it was recorded before the current session, for example.) The audio cannot be accurately synchronized with an analog tape recorder or video tape deck, since the original audio on your computer was not recorded referenced to the SMPTE Time Code from the analog tape deck or video tape deck.

### 2. Know the True Frame Rate on Your Work Tape

You may think this unlikely, but if you get your video tapes from a production company instead of recording them yourself, you are at their mercy as to what SMPTE frame rate is actually used on that tape. It may have been incorrectly labeled. Worse, it may be different than the frame rate of the SMPTE you have already striped on your audio tape! Be absolutely sure you know what SMPTE frame rate is used on any material you work with. The Digidesign Universal Slave Driver, Digidesign SMPTE Slave Driver, and some third-party products, can be used as a diagnostic tool for determining what frame rate is actually being used on a tape and whether or not it is running on speed. Consult the manuals for these units for details.

### 3. 29.97 fps Non-Drop Rate Can Pose Problems

29.97 fps Non-Drop is a slightly slower version of 30 fps Non-Drop time code. When used with color video, each video frame now matches up with each SMPTE frame without having to use a drop-frame coding. This makes any frame number mathematics much simpler, since no frame numbers are dropped.

Unfortunately, some hardware and software devices do not recognize 29.97 Non-Drop as a *separate frame rate.* For example, many SMPTE-to MTC-converters do not explicitly recognize it. The user must tell the convertor to expect 30 fps Non-Drop instead. In fact, many devices that read SMPTE work acceptably by reading 29.97 Non-Drop if they are set to expect 30 fps Non-Drop.

Unfortunately, any SMPTE reader that uses the time code numbers to make real-time calculations (as Pro Tools does when it tries to trigger and sync to SMPTE) *also* needs to know that the frame format is 29.97 and not 30 fps. Since both Pro Tools allows this choice of frame rate, this does not really pose a problem. The problem exists because many users cannot readily distinguish 29.97 from 30 fps. More importantly, some production companies will distribute video work prints striped with 29.97 fps but mark them as "30 fps NTSC," by which *they actually mean 29.97 fps Non-Drop!* By the time you get the tape, you may have no idea what's actually on it. Feeding 29.97 Non-Drop to Pro Tools when

it's set for 30 fps Non-Drop will result in timing errors of about 1.8 frames per minute, causing audio playback to trigger out of sync.

### 4. Be Careful When Changing Frame Rates

If you change time code rates in the middle of a session, many SMPTE-to-MIDI Time Code converters need to be turned off and turned on again to be able to recognize the new frame rate.

### 5. Resolve All Components of Your System

When striping time code, make sure that the time code generator and the video record deck are resolved to the same crystal reference. For example, when striping 29.97 Drop Frame time code onto a VTR, both the SMPTE generator and the VTR should be resolved to the same "black burst" or house sync generator. During playback, the master deck should be resolved to "black burst" or house sync. This convention provides compatibility for your tape between the record and playback passes, and when it's played back in other facilities on different equipment. This also means that when playing back a tape striped with time code, the playback deck should be resolved to the same sync rate as the record deck was resolved to at the time of the striping. When you stripe an audio transport with time code, it should be "free-running" and unresolved, but should be resolved with a house sync-referenced synchronizer during playback.

### 6. Use a Consistent Clock Source

A sound file should be played back using the same peripheral and sample rate it was recorded with, if at all possible. This assures the closest match between record and playback sample rates. For example, if an audio file was recorded at 44.1 kHz with the Pro Tools or AudioVision Audio Interface or Audio Card, then the Sample Rate should be set to 44.1 kHz during playback with the same Audio Interface or Audio Card as well.

### 7. Use the Current TC field in Pro Tools' Session Setup Window as a Reference

The Current TC field in Pro Tools' Session Setup Window indicates whether or not Pro Tools is receiving time code. If this field appears to be inactive when inputting time code into your time code reading device, check your hardware device settings, serial connection to your computer, and your OMS Setup. Make sure your OMS Setup correctly reflects the serial port and hardware you are currently using.

### 8. Avoid Appletalk, Networks, and Screen Savers

These types of software can cause the Macintosh to ignore MIDI data (such as MIDI Time Code) coming into its serial ports. The net effect of this is that an application (such as Pro Tools or AudioVision) will appear to lose SMPTE lock and sync, and drop in and out of lock repeatedly, every 5 or 10 seconds. Make sure Appletalk is inactive in the Chooser, disconnect Appletalk cables, and remove any INIT-based network software from your System Folder (QuickMail, Microsoft Mail, AppleShare, and so on).

## If All Else Fails....

If you've tried everything and you still can't get your Universal Slave Driver system to work properly, call Digidesign Technical Support at one of the phone numbers listed in the Registration Card for the Universal Slave Driver. Be sure to mention that you are using the Universal Slave Driver, the type of computer you are running, and whatever information that is relevant to your problem. The Digidesign Technical Support team will do everything they can do to help you get up and running.

# Glossary

# Glossary

Key cross-references are indicated in *italic*.

**882 I/O**

The model name of an *audio interface* from Digidesign, designed for use with Pro Tools software. The 882 I/O has eight *TRS* ("tip-ring sleeve") analog inputs and outputs; a pair of stereo (2-channel) *S/PDIF* in/out ports using RCA audio connectors; and a pair of Digidesign's proprietary, BNC-style Super Clock (256x) inputs and outputs.

**882 Studio**

The model name of an *audio interface* from Digidesign, designed for use with Session 8 software. The 882 Studio has eight *1/4"* analog inputs; four *XLR* Mic inputs; four *1/4"* Line inputs; a *1/4"* stereo headphone connector; a submix section; a pair of stereo (2-channel) *S/PDIF* in/out ports using RCA audio connectors; and a pair of Digidesign's proprietary, BNC-style Super Clock (256x) inputs and outputs.

**888 I/O**

The model name of an *audio interface* from Digidesign, designed for use with Pro Tools software. The 888 I/O has eight *XLR* analog inputs and outputs; four stereo *AES/EBU* digital audio connectors for (eight channels of AES/EBU audio); a pair of stereo (2-channel) *S/PDIF* in/out digital audio connectors, and a pair of Digidesign's proprietary, BNC-style Super Clock (256x) inputs and outputs.

**9-pin (Sony 9-pin; DB-9)**

An industry standard for serial machine control of professional video and audio transports, made by Sony and other manufacturers. Refers to the DB-9-style physical external control connector found on 9-pin-compatible devices.

The Universal Slave Driver does not offer any direct control or communication to or from its own 9-pin connectors. Instead, these connectors simply "pass-through" serial information from a Macintosh to compatible devices; this function also requires appropriate software, such as Digidesign's MachineControl software.

**Address (Time Code Address)**

A specific *SMPTE/EBU time code* reference or reading, in hours:minutes:seconds:frames. For instance, when the Universal Slave Driver is generating or regenerating time code, the current time code "address" is displayed in the front panel LCD Time Code window and in the USD Setup application window.

**AES/EBU Digital Audio**

Describes an audio industry interface standard for transfer of a single stereo stream of linear PCM digital audio data and an imbedded word clock between professional digital audio devices. AES/EBU stands for "Audio Engineering Society /European Broadcasters' Union." AES/EBU signals are usually routed via XLR connectors—unlike *analog audio*, a single XLR connector carries two channels of digital audio. However, the cable standard for AES/EBU specifies a twisted pair design, unlike standard microphone cable.

Also see *AES/EBU null clock*.

### AES/EBU Null Clock

All *AES/EBU digital audio* signals carry "1x" word clock information imbedded within its data stream, similar to the stand-alone digital standard clock signal known as *Word Clock*. If no digital audio information other than clock signal is passed via an AES/EBU data stream, this information is known as "null clock." The Universal Slave Driver can receive and transmit AES/EBU Null Clock information, but it does not recognize nor transmit any actual audio data. (If any audio data present is present, it is "stripped off.") Some digital studio facilities use AES/EBU Null Clock as their distribution medium for "master house sync" reference. In this application, each DAW, digital processor, or digital tape machine receives null clock and *resolves* to it as the device's *master sync source.*

### Amplitude

A term used by recording engineers to describe relative signal levels. See *Decibel*.

### Analog Audio

Audio which is transmitted, processed, amplified, or otherwise managed in the analog domain. Unlike digital audio, which represents audio in terms of discrete numbers, analog audio can be represented by continuously variable voltages.

### ATR

Audio Tape Recorder, of any format, including a Digital Audio Tape (DAT) deck.

### Audio Interface

Among many *DAWs*, such as Digidesign's Pro Tools, the audio interface is a separate box that is attached with a special cable to the audio card. An audio interface typically has *analog* and *digital audio* inputs, and may be equipped with level meters, level controls, and other features. The Universal Slave Driver is designed to support Digidesign's *888 I/O*, *882 I/O*, and *882 Studio* audio interfaces.

### Audio Post-Production

The process of editing and creating dialog, music, sound effects, and other audio to video, film, or a computer-based movie. The name "post-production" comes from the fact that these elements are modified or added once the film or video has already been "shot" in production.

### Balanced Audio

Most professional analog signals utilize balanced audio, with balanced cables and balanced connectors. Balanced lines are typically less susceptible to externally-generated noise or hum fields (such as 50/60 Hz hum, radio frequency interference, and so forth) than unbalanced lines. Analog balanced lines are typically distinguished by *XLR* connectors (although some use 3-conductor *1/4"* and *TRS* connectors).

Sometimes you need to connect a balanced output signal to an unbalanced input, such as if you were connecting the Universal Slave Driver's LTC output to an unbalanced audio input of a consumer-style VTR. If you are connecting an unbalanced signal to the Universal Slave Driver's balanced analog *LTC* input or output connector, refer to the wiring diagrams provided in Chapter 2.

### Bi-phase

An electronic reference signal commonly used by film mag recorders, film editing stations, and film projectors. Unlike *SMPTE/EBU time code*, bi-phase doesn't contain specific location information; rather, it simply supplies speed (based upon the frequency of the pulses) and direction. Since the Universal Slave Driver can "count" both the speed and direction of the stream of pulses, it can use a bi-phase source to deduce positional information.

A bi-phase signal is similar to a tach signal. However, they differ in the way they provide directional information. For more information, see Chapters 3 & 4.

**Bi-phase/Tach**

See *Tach*

**Black Burst (House Sync)**

Black burst is a type of *clock reference* that is essentially a video signal, without any visible picture, and without any "positional" information.

Many production facilities use a black burst generator to distribute "house sync" to much of their equipment. The Universal Slave Driver can be configured to use a black burst signal as a clock reference. Also see *Video Reference Signal*.

**Clock Reference**

A common "speed" reference, which various devices can use to establish synchronization during playback and recording.

Many audio and video devices (including ATRs, VTRs, and even DAWs) will operate at slightly different speeds; even a minute speed deviation can result in audible or visual synchronization errors. By *resolving* to a common clock reference, all of the devices will playback and record at exactly the same speed.

The Universal Slave Driver can be configured to operate as a *master* clock reference using its internal crystal-referenced clock. Alternately, it can be configured to resolve to an external clock reference, including:

- a *black burst* signal;
- a *video reference* signal;
- a *linear time code* signal;
- *word clock*;
- *Super Clock*;
- *AES/EBU null clock*;
- *pilot tone*; or
- *bi-phase/tach*.

To establish complete synchronization between a master and slave device, the Universal Slave Driver needs both a clock reference and a *positional reference*.

**DAW**

See *Digital Audio Workstation*.

**DB-9**

See *9-Pin*.

**dBu Level Standard**

There are a variety of different operating level scales, but for our purposes, the primary scale that allows us to measure different devices in the professional audio community on the same level "playing field" is known as dBu (not the same as dBV). Generally there are two standard operating level standards: +4 dBu for professional audio devices, and -10 dBV for consumer-grade (or semi-professional) devices. The Universal Slave Driver has adjustable *LTC* output levels, ranging from –24 dBu to +9 dBu.

**Decibel**

The primary unit for measuring audio levels (i.e. how apparently loud a given sound is to our ears). The decibel is a subunit of the "Bel," and a decibel is 1/10th of a bel. It is also spelled deciBel, named after inventor Alexander Graham Bell.

**Digidesign Super Clock**

See *Super Clock.*

### Digital Audio

Audio which is transmitted, processed, amplified, or otherwise managed in the digital domain. Digital audio uses numbers—bits comprised of "0" or "1"—to represent sound. Digital audio requires an A/D *(analog to digital)* converter to convert sound from analog into digital, and a D/A *(digital to analog)* converter to convert it back to analog. Digital audio quality can generally be characterized by two parameters: the bit-rate resolution and the sampling rate. This is because the process of converting audio from an analog signal to a digital signal (and back again) depends upon these two factors for the best representation of the original signal.

### Digital (Clock Reference)

The Universal Slave Driver is able to use three different types of digital signals as a *clock reference*: *AES/EBU null clock*; *Super Clock*; and *word clock*. Please refer to their respective definitions for more information.

### Digital Audio Workstation (DAW)

A common name for a *hard disk recording* system that can be used to record, edit, and mix audio. Certain DAWs such as Digidesign's Pro Tools use a personal computer as a "host," and also use an additional audio card and *audio interface* .

### Drop-Frame

Refers to a variance of *SMPTE/EBU time code* which omits two frames (frames "0" and "1") every minute except for every tenth minute. Drop-frame format compensates for the fact that 29.97 frame-rate time code runs "slow" by 3.6 seconds every hour compared to a 30 frame-per-second timing reference; that is, "one hour" of 29.97 non-drop time code is equal to one hour and 3.6 seconds of real time, due to the fact that the slower frame rate does not match "wall clock." Dropping—or more descriptively, skipping—frames allows this format to "jump ahead," in order to maintain a true relationship between the time code and "real time," so that one hour of 29.97 drop-fame does indeed last exactly one hour of real time. For these reasons, "drop" time code is more accurate (in terms of real time) than "non-drop."

Drop-frame time code usually refers specifically to 29.97 fps drop-frame. Though much less common, 30fps drop-frame time code is sometimes used in certain video/film transfer situations. The Universal Slave Driver supports drop-frame and non-drop frame for both 29.97 and 30 fps time code.

### Frames Per Second (FPS)

The number of frames which elapse per second, as defined by the four *SMPTE/EBU Time Code* fps standards. These include:

- 24 fps (for film applications);
- 25 fps (the *PAL/SECAM* video standard);
- 29.97 fps (the *NTSC* color video standard); and
- 30 fps (the *NTSC* black and white video standard).

Also see *Drop-Frame*.

### General Purpose Interface (GPI)

Stands for General Purpose Interface. Professional *video editing systems* (and other audio studio systems) offer contact-closure-style switches (in addition to *machine control*), which can be custom-wired to start and stop "non-syncable" devices such as cart machines, slide projectors, etc. The Universal Slave Driver's cannot control its GPI inputs and outputs directly; rather, they can be controlled only by application software resident in the host computer. *(Support of GPI features will be available in an upcoming software release. Stay tuned!)*

**Generation**

See *Time Code Generation*

**GPI**

See *General Purpose Interface*.

**Hard Disk Recording**

Digital recording that records and plays back audio to and from a hard disk, as opposed to tape. A hard disk recording system is more commonly called a *digital audio workstation* (DAW).

**House Sync**

See *Black Burst*

**I/O**

An abbreviation for *Input/Output*. "I/Os" is an abbreviation for Inputs/Outputs.

**LTC**

Linear Time Code; formerly known as *Logitudinal Time Code*. This version of *SMPTE/EBU time code* resides on a linear track, such as an audio track or the control track of a video tape. An LTC signal is actually an analog audio signal, and thus can be recorded and played back much like an audio track. However, an LTC signal cannot be read off of tape while the tape is "crawling" at a very slow speed, or is paused or stopped. An LTC signal also requires a wide-band time code reader if sync is required in fast-winds or slower speed.

**Master**

The "lead" machine or *DAW* in a synchronized machine arrangement. *Slaves* follow masters. There can only be only master at any given time.

**MIDI**

The Musical Instrument Digital Interface standard, which is a serial digital protocol standard that musical instruments, recording equipment, and computers can use to communicate information between one another. MIDI uses 5-pin "DIN" connectors.

**MIDI Time code**

See *MTC*.

**MTC**

Stands for MIDI (Musical Instrument Digital Interface) Time Code—an industry standard for transmitting the MIDI equivalent of *SMPTE/EBU time code* between devices. While not the same as SMPTE time code (it's a digital, rather than analog signal, for one), a SMPTE-to-MTC converter can be used to bridge the gap. MTC can follow all the frame-per-second rates of SMPTE time code. The Universal Slave Driver is able to output MTC based upon a variety of *clock* and *positional references*.

**Non-Drop Frame**

Time code which is not in *drop-frame* format. In the United States, the standard format outside of color video production or post-production is typically 29.97 fps non-drop frame.

**Nonlinear Digital Video Editing System**

A video equivalent of a *DAW*. Most such systems are Mac- or PC-based, and record compressed digital video information to hard disks or optical disks, for completely random-access editing of both visuals and audio information.

**NTSC**

Refers to the video standards developed by the National Television Standards Committee. NTSC color video runs at 29.97 *frames per second*; NTSC black and white video runs at 30 fps. Used primarily in North and South America and Japan.

### Null Clock

See *AES/EBU Digital Audio.*

### OMS

Open Music System, developed by Opcode. OMS is a "MIDI operating system" for Macintosh computers. It handles the exchange of MIDI data between applications, including timing signals such as *MTC*. This information can be shared between OMS-compatible application programs, such as Pro Tools. Using OMS, for instance, Pro Tools can communicate with and synchronize to such full-featured sequencing software packages as Opcode's Vision™, Mark of the Unicorn's Performer™, Emagic's Logic™ and Steinberg's Cubase™. For instance, OMS allows you to record Pro Tools tracks while you listen to a previously recorded MIDI sequence playing from a third-party seqencer. The Universal Slave Driver can be configured as an OMS-compatible device, as described in Chapter 2.

### PAL

Phase alternate line; refers to the video standard used in most of Europe and Asia, and some parts of Africa. Like *SECAM*, PAL-standard video runs at 25 *frames per second*.

### Pilot Tone

A sine wave signal derived by clock-referencing the AC line frequency (typically 50Hz or 60Hz); most commonly used in on-location film productions to establish a common sync reference between a film or video camera with a portable analog ATR.

### Positional Reference

A common reference which provides location information, which various devices can use to establish synchronization during playback and recording. Most commonly, the information is delivered in the form of *SMPTE/EBU Time Code*.

The Universal Slave Driver can be configured to operate as a *master* positional reference when configured to function as a time code generator. Alternately, it can be configured to synchronize to an external positional reference, including:

- *Linear Time Code* (LTC);
- *Vertical Interval Time Code* (VITC);
- Both LTC and VITC (Auto-Switch LTC/VITC mode); or
- *Bi-phase/Tach*.

To establish complete synchronization between a master and slave device, the Universal Slave Driver needs both a positional reference and a *clock reference*.

### Pull Up/Pull Down

Refer to the deliberate "miscalibration" of the audio *sample rate* clock (the audio pitch) in order to compensate for a speed change elsewhere in the production chain. The usual situation in which these rates are encountered is when film footage (at 24 fps) is transferred to color NTSC-standard video tape (at 29.97 fps).

The Universal Slave Driver supports Pull Up and Pull Down at both the 44.1 kHz and 48 kHz nominal sample rates.

### Pulses Per Frame (PPF)

Refers to the number of pulses per frame that a *Bi-phase* or *Tach* signal is generating. By setting the PPF rate, the Universal Slave Driver can use a Bi-phase or Tach signal as a *clock reference*.
See *Time Code Regeneration*

### Regeneration

See *Time Code Regeneration*

### Resolving

Resolving is the process of synchronizing one device to another; more specifically, resolving refers to synchronizing a device's clock to an external *clock reference*. Less commonly (and less accurately), resolving can also refer to synchronizing a device to an external *positional reference*.

### Sample Frequency

See *Sample Rate*.

### Sample Rate

Sample rate most commonly has a bearing on audio quality and file size. However, in regard to the Universal Slave Driver, clock speed can have a direct bearing on a *DAW's* sample rate.

In digital audio, sample rate refers to how frequently incoming audio is "sampled" as its converted from an analog to a digital signal. A sample is like an instantaneous "snapshot" of sound; if you take lots of snapshots and string them together, you can get an accurate representation of what's going on, sound wise—just like a movie is a strung-together collection of pictures. High-quality audio is usually sampled 44,100 times, or cycles, per second, and is often referred to as a "44.1 kiloHertz" (44.1kHz) sample rate. Some people use a higher sample rate of 48kHz, especially for audio-for-picture applications. However, for music production, a 48kHz recording be "sample rate converted" if it's to be used on an audio CD, so it may be preferable to stick to 44.1kHz. Lower sample rates are also possible: Broadcasters sometimes work at a 32kHz rate, and many games and other multimedia programs use audio sampled at a 22kHz or even 11kHz rate.

As mentioned earlier, in regard to the Universal Slave Driver, clock speed can have a direct bearing on a DAW's sample rate. For instance, when the Universal Slave Driver is used to slave Pro Tools (or AudioVision) to an external *clock reference*, the Universal Slave Driver will adjust Pro Tools' (or AudioVision's) sample rate to match the clock reference's speed deviations.

Also see *Pull Up/Pull Down*.

### SECAM

Séquential couleur à mémoire; refers to the video standard used in France, Russia, most of Eastern Europe, and parts of Africa. Like *PAL*, SECAM video runs at 25 *frames per second*.

### Slave

A device which "follows" the *master* during synchronization.

### SMPTE/EBU Time Code

Standard time code, as developed by the Society of Motion Picture and Television Engineers and the European Broadcasters' Union. SMPTE/EBU time code divides time into hours:minutes:seconds:frames. (In some situations, each frame is further divided into 80 or 100 subframes.) Typical *frames-per-second* (fps) rates include 24 (film), 25 (European video), 29.97 (North American Color Video), and 30 (North American B&W video). 30fps time code can be in *drop-frame* or *non-drop-frame* formats. Also see *MTC*.

### Sony 9-pin

See *9-Pin*.

### Sources & Destinations

Signals are routed from sources (such as a VTR) to destinations (such as the Universal Slave Driver's *Video Ref In* connector).

### S/PDIF Digital Audio Connector

Describes an industry standard connector, used for transferring digital audio between audio devices; essentially a semi-professional version of the *AES/EBU* standard. Stands for "Sony/Philips Digital Interface Format." Most S/PDIF connections utilize *RCA* in/out connectors, carrying two channels of digital audio at a time (as opposed to one channel of analog audio). The Universal Slave Driver has *AES/EBU* connectors, but not S/PDIF connectors.

### Striping (Time Code)

The process of:

- inserting VITC into a video signal, or
- recording LTC onto an ATR's (or VTR's) audio track (or cue track)

The Universal Slave Driver can stripe both VITC and LTC.

### Super Clock (256x)

Digidesign's proprietary version of *word clock*; used as a *clock reference*. All Digidesign audio interfaces, and several other Digidesign products (including the Universal Slave Driver, the ADAT Interface, the SMPTE Slave Driver, and the Video Slave Driver) are equipped with BNC-style Super Clock inputs and outputs.

As with word clock, Super Clock is a clock signal that can be passed between devices independently of the audio signal. Since it runs at 256x sample rate (instead of word clock's 1x sample rate), Super Clock is inherently more precise than Word Clock.

### Synchronizer

Usually a stand-alone device, such as the Universal Slave Driver, which can synchronize a *slave* device to a *master* device, so that they are "locked" and run together accurately. To perform complete synchronization, a synchronizer needs both a *clock reference* and a *positional reference*, so that it can match the slave to both the master's speed and location.

A transport synchronizer refers to a type of synchronizer that can electronically control the actual motor speed of a slaved ATR or VTR.

### Synchronization

The process of having two or more audio or video devices run together at exactly the same speed during playback and record. (Although in some cases, synchronization during fast-winds and "crawls" is possible.) Professional applications require the use of an external or plug-in "transport synchronizer." With an affordable DAW, such as Digidesign's Session, synchronization is usually performed either between Session and a sequencer using *OMS*, or in Trigger Sync mode, where an external SMPTE-to-MTC converter (such as Opcode's Studio 4 interface) sends a "start" signal to the DAW at a predetermined start time.

### Tach

An electronic pulse used commonly by some film equipment and other motor-driven devices. Unlike *SMPTE/EBU time code*, tach doesn't contain specific location information; rather, it simply supplies speed (based upon the frequency of the pulses) and direction. However, since the Universal Slave Driver can "count" both the speed and direction of the stream of pulses, it can use a tach source to deduce positional information.

A tach signal is similar to a *bi-phase* signal. However, they differ in the way they provide directional information.

**Time Code**

See *SMPTE/EBU Time Code* and *MTC.*

**Time Code Generator**

A crystal-locked, highly accurate time code source. The Universal Slave Driver has a built-in time code generator.

**Time Code Generation**

The process of creating "fresh" time code. The Universal Slave Driver generates time code whenever its positional reference is set to "Generate." Also see *Time Code Regeneration*.

**Time Code Regeneration**

The process of creating time code based upon an existing time code source or positional reference. The Universal Slave Driver regenerates time code whenever its positional reference is set to something other than "Generate"—assuming that a valid external time code source or positional reference is available.

**Transport Synchronizer**

See *Synchronizer.*

**Time Code Window**

See *Window Dub.*

**Video Reference Signal**

All video signals contain clock information, which can be used as a *clock reference*. The Universal Slave Driver has two video input connectors: Video Ref In and Video In. Typically, the Video Ref In connector is used for a *black burst* signal; the Video In connector is used for a "conventional" video signal. The Universal Slave Driver can reference signals at either connector to provide a clock reference.

**VITC (Vertical Interval Time Code)**

Stands for Vertical Interval Time Code. Unlike LTC, which is analogous to an audio signal, VITC is stored within the "vertical blanking interval" of the video tape, embedded as part of the video signal. Provides true frame-accurate time code relative to the video. Can also be read while a video tape is paused or stopped, because the video heads continue to spin relative to the tape. Requires a more specialized form of time code reader than LTC. Pronounced *vit-see*.

**VTR**

A video tape recorder. Professionals use this term instead of "VCR" (for video cassette recorder) since some professional VTRs use open-reel tape instead of cassette tape.

**Window Dub (Window Burn; Time Code Window)**

A window dub offers a display of time code that can be seen superimposed over a video signal. Also called a window burn, or time code window, a window dub displays time code in hours:minutes:seconds:frames. Typically, these numbers will match the time code *addresses* of any LTC or VITC that may be associated with the video signal. A window dub can be very helpful for anyone involved in audio-for-picture, since it gives you an instant visual cue as to where you are in time.

The Universal Slave Driver has the ability to superimpose a window dub onto a video signal.

**Word Clock (1x)**

A type of *clock reference* standard used by certain digital mixing consoles, multitrack digital audio tape recorders, and other digital audio devices. Word clock information is similar to *AES/EBU null clock* information, in that it runs at 1x sample rate, although it typically uses BNC-style connectors, rather than *XLR* connector. The Universal Slave Driver can both generate and resolve to word clock information.

**XLR (3-pin) Connector**

A common connector for professional audio devices, that utilizes balanced analog audio and AES/EBU digital audio connections. (See *Balanced Audio*.) The Universal Slave Driver uses XLRs for its LTC In and Out connectors, as well as its AES/EBU In and Out connectors. The Universal Slave Driver's analog LTC In and Out connectors are phase independent, which means that the signal can be either pin 2 or pin 3 "hot."

# Appendices

# Appendix I
# Technical Specifications & Connector Pin-outs

## General

**Nominal Sample Rates**

44056 Hz (Pull Down)
44100 Hz
44144 Hz (Pull Up)

47952 Hz (Pull Down)
48000 Hz
48048 Hz (Pull Up)

**Frame Rates**

30 fps (frames per second)
30 fps drop-frame
29.97 fps
29.97 fps drop-frame
25 fps
24 fps

**Variable Speed Override**

± 699 cents (± 58.25%)

**Resolver Lock Time**

| | |
|---|---|
| LTC: | 750 msec |
| Video: | 1.5 sec |
| Word Clock: | 750 msec |
| Super Clock: | 1.5 s (1.0 s typical) |
| AES/EBU: | 750 msec |
| Bi-phase: | 1.0 sec |
| Pilot: | 1.1 sec (60 Hz), 1.3 sec (50 Hz) |

**Frequency Reference**

| | |
|---|---|
| Stability: | ± 5 ppm from 50 to 131 degrees F (10 to 55 degrees C) |
| Aging: | ± 2 ppm/year typical |

**Burn-in Window**

| | |
|---|---|
| Position: | 5 horizontal and vertical positions |
| Size: | Large and small text |
| Color: | Black or white text on white or black background or keyed over video |

| | | |
|---|---|---|
| **Mechanical Format** | Height: | 1RU/1.75" (4.45 cm) |
| | Width: | 19.0" (48.26 cm) |
| | Depth: | 10.5" (26.67 cm) |
| **Weight** | 5.0 lbs (2.27 kg) | |
| **Vibration Resistance** | 5 mm displacement, 10 to 55 Hz, each axis | |
| **Shock** | 5 G max | |
| **Operating Temperature** | 32 to 131 degrees F (0 to 55 degrees C) | |
| **Storage Temperature** | -40 to 176 degrees F (-40 to 80 degrees C) | |
| **Relative Humidity** | 0 to 95%, non-condensing | |
| **Power Requirements** | Voltage: | 85 to 264 VAC |
| | Frequency: | 47 to 63 Hz autoswitching |
| | Wattage: | 9.5 W typical, 30 W maximum |
| | Connector: | 3-pin, AC and ground (IEC 950:320;3.2.4) |
| **Agency Compliance** | Meets FCC Part 15 Class A limits, CE EN 55022A, CE EN 60950, CE EN 55082:1, UL 1419 and CSA 22.2 | |

## Rear Panel Connectors

| | | |
|---|---|---|
| **LTC In** | Format: | SMPTE 80-bit longitudinal, drop frame/non-drop frame |
| | Connector: | 3-pin XLR female per IEC 268-12 |
| | Speed Range: | 1/30 to 80X play speed, forward or backward |
| | Level: | -24 dBu to +9 dBu, differential (pin 2 hot) |
| | Impedance: | 200K ohms |
| **LTC Out** | Format: | SMPTE 80-bit longitudinal, drop frame/non-drop frame |
| | Connector: | 3-pin XLR male per IEC 268-12 |
| | Speed Range: | ± 10% of playspeed |
| | Level: | -24 dBu thru +9 dBu RMS, differential (pin 2 hot) |
| | Level Default: | 0 dBu RMS, 1.52V p-p ± 10mV |
| | Output Impedance: | 5K ohms |
| | Load Impedance (min): | 600 ohms |
| | Rise/Fall Time: | 42us ± 1us measured between 10% and 90% p-p |
| | S/N Ratio: | -60 dB RMS at 0 dBu level |

| | | |
|---|---|---|
| **Video Sync In** | Format: | NTSC or PAL video sync (black-burst) |
| | Connector: | BNC Female |
| **Video (Main) In** | Level: | 1V p-p |
| | Termination: | 75 ohms |
| **Video (Main) Out** | Level: | 1V p-p |
| | Termination: | 75 ohms |
| **Video (Ref) In** | Level: | 1V p-p |
| | Termination: | 100K ohms |
| **Video (Ref) Out** | Level: | 1V p-p |
| | Termination: | 100K ohms |
| | Description: | Passive pass-thru of Video Ref in |
| **AES Clock In** | Level: | 5 V p-p at 110 ohms (pin 2 hot) |
| | Connector: | 3-pin XLR female per IEC 268-12 |
| **AES Clock Out** | Level: | 5 V p-p at 110 ohms (pin 2 hot) |
| | Connector: | 3-pin XLR male per IEC 268-12 |
| **Word Clock In** | Level: | 0 to .5 V (low), 2.0 to 6.0 V (high) |
| | Connector: | BNC Female |
| **Word Clock Out** | Level: | TTL (3.3 V typical) |
| | Connector: | BNC Female |
| **Super Clock In** | Level: | 0 to .5 V (low), 2.0 to 6.0 V (high) |
| | Connector: | BNC Female |
| **Super Clock Out** | Level: | TTL (3.3 V typical) |
| | Connector: | BNC Female |
| **Bi-phase/Tach/ GPI/Pilot** | Connector: | 25-pin D-subminiature female (DB25) |
| **Bi-phase/Tach In** | Frequency Range: | 0 to 76.8 KHz |
| | Level: | 3.0 to 5.5 V, opto-isolated |
| | Current: | 10 mA max |
| | Polarity (bi-phase): | Both inputs are software programmable |
| | Polarity (tach): | “Direction” polarity is software programmable |
| | Modulo Range: | 2 thru 254 |

| | | |
|---|---|---|
| **Pilot In** | Level: | 100 mV to 5.5 V p-p, differential |
| | Frequency Range: | 50/60 Hz nominal |
| | Impedance: | 200K ohms |
| **GPI In** | Description: | Four opto-isolator inputs/returns |
| | Level: | 3.0 to 5.5 V |
| | Current: | 10 mA max |
| | Frequency: | Frame-rate max |
| | Latency: | Half frame max |
| **GPI Out (TTL)** | Description: | Two TTL-level outputs |
| | Level: | TTL (3.3 V typical) |
| | Current: | 15 mA |
| | Frequency: | Frame-rate max |
| | Latency: | Half-frame max |
| **GPI (Relay)** | Description: | Four pairs of SPST contacts, normally open |
| | Load (while switching): | .5 A max at 200 VDC |
| | Load (continuous): | 1.5 A max at 200 VDC |
| | Operate/Release Time: | 1 ms |
| | Repetition Rate: | Frame-rate max |
| | Latency: | Half frame max |
| **MIDI Time Code Out** | Current Rating: | 15 mA current loop |
| | Rate: | 31.25 Kbaud |
| | Connector: | 5-pin DIN female |
| | Cable Length: | 50 feet (15 meters) max |
| **9-pin Serial In** | Format: | RS-422, supports Sony 9-pin specs for slave in device |
| | Interface: | ANSI/SMPTE 207M-1984 standard |
| | Rate: | 38.4 Kbaud max |
| | Connector: | 9-pin D-subminiature female (DB9) |
| | Cable Length: | 50 feet (15 meters) max |
| **9-pin Serial Out** | Rate: | 38.4 Kbaud max |
| | Interface: | ANSI/SMPTE 207M-1984 standard |
| | Connector: | 9-pin D-subminiature female (DB9) |
| | Cable Length: | 50 feet (15 meters) max |
| **Mac Serial** | Format: | Apple Macintosh-compatible serial printer port |
| | Connector: | 8-pin mini DIN female |
| | Cable Length: | 50 feet (15 meters) max |

| | | |
|---|---|---|
| **PC Serial** | Format: | PC-compatible RS-232 serial port |
| | Connector: | 25-pin D-subminiature female (DB25) |
| | Cable Length: | 50 feet (15 meters) max |
| **VITC In** | Format | SMPTE 90-bit, drop frame/non-drop frame |
| | Line Range: | 10 to 40 (all-line mode), 10 to 22 (single-line mode) |
| **VITC Out** | Format: | SMPTE 90-bit, drop frame/non-drop frame |
| | Line Range: | Two lines, 10 to 20 |

## Connector Pin Assignments

### Mac Serial Port

| Pin # | Name | Description | Mac Connection |
|---|---|---|---|
| 1 | NC | No connection | Pin 2 (HSKiB) |
| 2 | RTS_IN | Request To Send (input to USD) | Pin 1 (HSKoB) |
| 3 | RX_OUT | Transmitted data (output from USD) | Pin 5 input (RXDB-) |
| 4 | GND | Chassis ground | Ground |
| 5 | TX_IN | Received data (input to USD) | Pin 3 output (TXDB-) |
| 6 | GND | Chassis ground | Pin 8 input (RXDB+) |
| 7 | CTS_OUT | Clear To Send (output from USD) | Pin 7 input (GPiB) |
| 8 | NC | No connection | Pin 6 (TXDB+) |
| Shell | GND | Chassis ground | Ground |

### PC Serial Port

| Pin # | Name | Description |
|---|---|---|
| 1 | GND | Connected to chassis ground |
| 2 | TX_IN | Received data (input to USD) |
| 3 | RX_OUT | Transmitted data (output from USD) |
| 4 | RTS_IN | Request To Send (input to USD) |
| 5 | CTS_OUT | Clear To Send (output from USD) |
| 6 | NC | No Connection |
| 7 | GND | Connected to chassis ground |
| 8-25 | NC | No Connection |
| Shell | GND | Connected to chassis ground |

**9-pin Serial Input Port**

| Pin # | Name | Description |
|---|---|---|
| 1 | NC | No Connection |
| 2 | TX1- | Transmitted data (output from USD) |
| 3 | RX1+ | Received data (input to USD) |
| 4 | GND | Connected to chassis ground |
| 5 | RTS | Request To Send* (Output from USD) |
| 6 | GND | Connected to chassis ground |
| 7 | TX1+ | Transmitted data (output from USD) |
| 8 | RX1- | Received data (input to USD) |
| 9 | NC | No Connection |
| Shell | GND | Connected to chassis ground |

**9-pin Serial Output Port**

| Pin # | Name | Description |
|---|---|---|
| 1 | NC | No Connection |
| 2 | RX2- | Received data (input to USD) |
| 3 | TX2+ | Transmitted data (output from USD) |
| 4 | GND | Connected to chassis ground |
| 5 | RTS | Request To Send* (Output from USD) |
| 6 | GND | Connected to chassis ground |
| 7 | RX2+ | Received data (input to USD) |
| 8 | TX2- | Transmitted data (output from USD) |
| 9 | NC | No Connection |
| Shell | GND | Connected to chassis ground |

* This instance of RTS is buffered directly from the RTS input of the Mac and PC serial ports. It is output from the 9-pin ports for compatibility with other equipment.

**Bi-phase/Tach/GPI/Pilot Port (Accessory Port)**

| Pin # | Name | Description |
|---|---|---|
| 1 | GPOUT0 | GPI TTL-level output 0 |
| 2 | GPOUT1 | GPI TTL-level output 1 |
| 3 | GPOUT0_A | GPI Relay 0, contact A |
| 4 | GPOUT0_B | GPI Relay 0, contact B |
| 5 | GPOUT1_A | GPI Relay 1, contact A |
| 6 | GPOUT1_B | GPI Relay 1, contact B |
| 7 | GPOUT2_A | GPI Relay 2, contact A |
| 8 | GPOUT2_B | GPI Relay 2, contact B |
| 9 | GPOUT3_A | GPI Relay 3, contact A |
| 10 | GPOUT3_B | GPI Relay 3, contact B |

| | | |
|---|---|---|
| 11 | OPTRETURN | Return from Biphase/Tach opto-isolators |
| 12 | BIPHB_I | Input to Bi-phase/Tach opto-isolator B |
| 13 | BIPHA_I | Input to Bi-phase/Tach opto-isolator A |
| 14 | GND | Chassis ground |
| 15 | PILOT_IN- | Pilot tone input, negative |
| 16 | PILOT_IN+ | Pilot tone input, positive |
| 17 | RET0 | Return from GPI opto-isolator “0” |
| 18 | GPIN0 | Input to GPI opto-isolator “0” |
| 19 | RET1 | Return from GPI opto-isolator “1” |
| 20 | GPIN1 | Input to GPI opto-isolator “1” |
| 21 | RET2 | Return from GPI opto-isolator “2” |
| 22 | GPIN2 | Input to GPI opto-isolator “2” |
| 23 | RET3 | Return from GPI opto-isolator “3” |
| 24 | GPIN3 | Input to GPI opto-isolator “3” |
| 25 | VDD | +5V DC, fuse protected (see notes below) |
| Shell | GND | Connected to chassis ground |



**Bi-phase/Tach/GPI/Pilot Port Interfacing Notes:**

- The six opto-isolators are 6N137 devices. Each port input passes through a 390 ohm series resistor to the cathode. Each port return comes directly from the anode. The bi-phase/tach inputs share the same return.
- The two TTL-level GPI outputs are driven by a 74FCT541. Each output passes through a 220 ohm series resistor.
- The fuse is thermally activated. The current rating varies between 1.0 A at 60°C and 1.5 A at 20°C. The time to trip varies with temperature and current. The typical time to trip at 1.5 A is 5 minutes. Time to trip at 8 A is 5 seconds. After tripping, the fuse will return to it’s low-resistance state when the current is reduced sufficiently.
- For Tach, the “rate” input is “BIPHA_I” and the “direction” input is “BIPHB_I.” The polarity of “BIPHB_I” is software programmable and defaults to “low” for “forward.”
- For Bi-phase, the default polarity relationship between A and B is software programmable. The default setting for “forward” is “A leads B.” This means that the rising edge of A (0° phase) must preceed the rising edge of B (90° phase).
- For highest signal quality, use a 25-pin cable with individually shielded conductors.

# Appendix II
# Calibrating the USD Oscillator

The Universal Slave Driver provides a feature for calibrating the frequency of the on-board crystal oscillator. This allows the frequency of the output clocks to be "fine-tuned" to an extremely high precision. Once calibrated, the Universal Slave Driver may be used as an extremely accurate frequency reference while in *Internal/VSO* mode.

With normal usage, the Universal Slave Driver should never require recalibrating. Each unit is factory-calibrated to within +/- 5 ppm (parts per million). This should be sufficient for most users. However, advanced users may wish to recalibrate their unit in the following unusual situations:

- If greater than 5 ppm accuracy is required;
- If the unit needs to be matched to a unique (nonstandard) frequency such as a house clock reference;
- To precisely compensate for component aging;
- To restore the original factory setting after it's been changed.

As a side-note, the "calibration" units are in 1/64th of a sample period. What this means is that the Universal Slave Driver can theoretically be calibrated to about 1/3 of a ppm. The unit will maintain calibration across a wide range in temperature. Long-term drift should be less than one ppm per year due to aging of the crystal. To put this in perspective, most digital audio products are accurate to within 20 to 50 ppm and drift with temperature. The Universal Slave Driver's accuracy is possible because it contains a low-jitter, high-stability temperature controlled crystal oscillator.



*Tip: Before you begin the calibration procedure, power on the Universal Slave Driver and allow it to warm up for at least five minutes. The temperature of the room (or chassis) isn't critical during the calibration procedure. However, if you need better than 3 ppm accuracy, it is recommended that you allow the Universal Slave Driver to warm up for at least 30 minutes and that the chassis be at normal operating temperature.*

***To restore the Universal Slave Driver's oscillator calibration to its factory setting:***

1. Set the Universal Slave Driver to the oscillator calibration mode using the front panel controls. Select the Universal Slave Driver's last "normally" accessed parameter name—which is Video System (*VIdEo SY*)—using the *Set*, *Down*, and *Up* switches (as described in Chapter 4).

2. With the LED Time Code Display showing *VIdEo SY*, press and hold the *Up* switch. While you continue to hold that switch, press the *Clock Reference* switch momentarily, and then release both switches. The LED Time Code Display will read:


3. Press the *Set* switch again. The LED Time Code Display will switch to display the current parameter value, which shows a sample rate frequency deviation from *–0999* to *0999*.

4. Take note of the Oscillator Calibration value printed on the factory sticker, affixed on the Universal Slave Driver's bottom panel.

5. Use the *Down* and *Up* switches to scroll through the parameter values. Pressing and releasing the switches will change the value by just one incremental value. Pressing and holding the switches will scroll at a faster speed.

6. When you reach a value which matches the sticker's value, stop scrolling and press *Set*. The LED Time Code Display will return to showing time code numbers. Your Universal Slave Driver is now properly calibrated.

7. The next time you press *Set*, the LED Time Code Display will again show *O5C CAL*. If you then press the *Down* switch, you'll disengage the Oscillator Calibration parameter name. To change the setting once again, you'll need to repeat steps 1 through 6.

# Appendix III
# Bibliography

For more information regarding concepts and applications discussed in this User's Guide, we recommend the following sources: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