

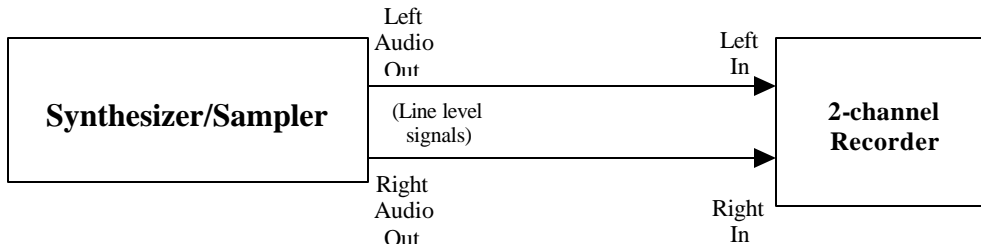
# HOW TO SET UP YOUR HOME STUDIO

## By John J. Volanski

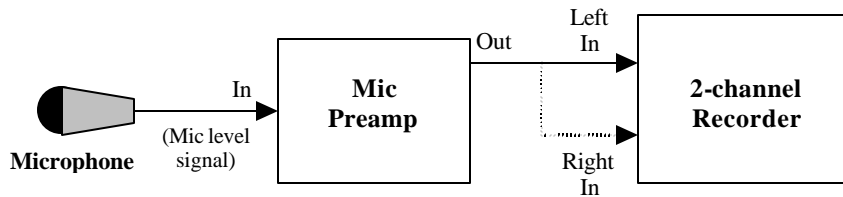
This article was written as additional instructional material to be used in conjunction with the book *Sound Recording Advice*. It is an updated and rewritten version of an article I originally wrote for *Electronic Musician* magazine (as mentioned on page 27 of the book). Seven different equipment connection schemes are presented in increasing order of complexity, plus an additional block diagram is presented to show typical connections to a generic analog mixer. For any terms or technical issues you don't understand, please refer to the book for a more thorough explanation.

### Connection Scheme 1:

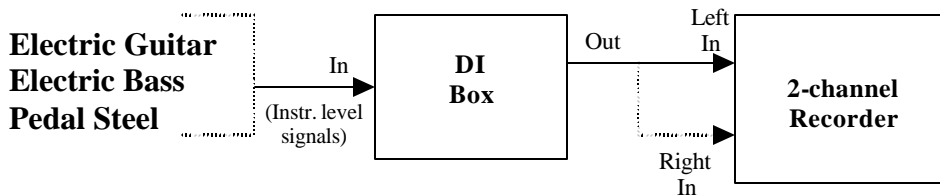
Figure 1 shows 3 different connection schemes. They look almost laughably simple. The first one (Figure 1A) shows a line-level electrical musical instrument such as a synthesizer or sampler feeding into a 2-channel recorder. The 2-channel recorder could be a cassette deck, a reel-to-reel (R/R) recorder, a MiniDisc recorder, a PCM digital recorder, a VHS Hi-Fi VCR, or even a standalone CD-R or CD-RW recorder. Figure 1B shows how to transform the mic-level signal from a microphone into a line-level signal for a 2-channel recorder; a mic preamp of some sort must be used to amplify the mic-level signal (usually a couple of milliVolts) to a line-level amplitude (usually about 750 mV). This mic preamp can be a standalone unit (such as the Symetrix SX-202), or it can be incorporated into the channel strip of a mixer. Phantom power may or may not be required depending on the type of microphone used. Figure 1C shows how to connect a guitar to a line-level 2-channel recorder. In the diagram, I show the use of a DI (Direct Inject) Box. The DI Box will take the instrument level signal (in the low milliVolts range) and amplify it with the correct impedance to match the line-level equipment downstream. In place of a DI Box, you can substitute an effects stomp box or an amp/cabinet modeler.



**Figure 1A: Electrical Instrument**



**Figure 1B: Acoustic Instrument**



**Figure 1C: DI Instrument**

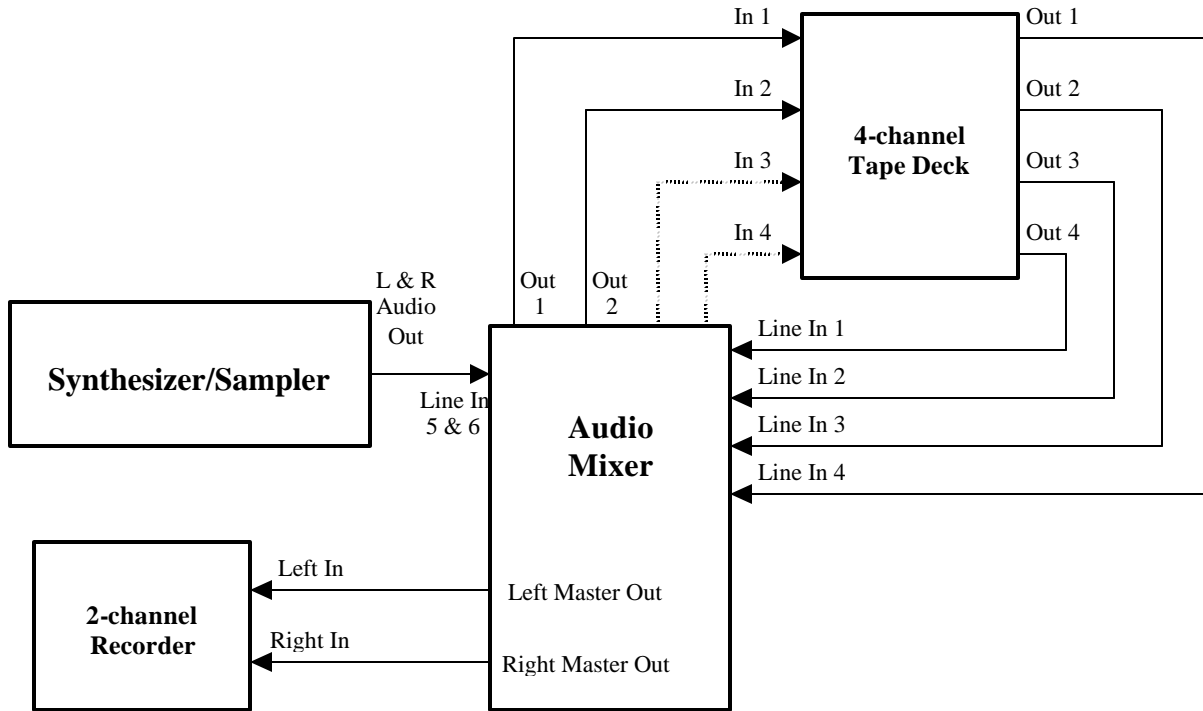
All of these schemes in Figure 1 are fairly limited in scope and flexibility, since the 2-channel recorder does not have multitracking capability— all of the schemes, that is, except the one shown in Figure 1A. Granted, if the synthesizer is a monophonic synthesizer and the 2-channel recorder is a cassette deck, the overall sonic result is bound to be unremarkable. However, what if the synthesizer is a monster such as the Kurzweil K2600, Yamaha Motif or the Korg Triton (with an onboard sequencer, onboard digital effects, onboard sampled drum kits and multiple simultaneous voices)? And what if the 2-channel recorder is a standalone CD-R recorder such as one of the Marantz, HHB, Sony, Denon, Philips or Tascam units? Suddenly, those same two boxes in the diagram will allow you to generate studio-quality recordings direct to CD-R. My point is that you can generate a professional instrumental recording even with the simple set-up shown in Figure 1A.

If your synthesizer, mic preamp or DI box does not have a stereo output, you can do one of two things. You can use a Y-cord on the output of the synthesizer, mic preamp or DI box to turn the single output into 2 outputs to go into both inputs of the 2-channel recorder. A better (but more costly) solution is to use a digital or analog delay device to delay one input to the 2-channel recorder by about 25mS while leaving the other input dry. This will create a pseudo-stereo effect. See pages 223 and 232 in the book for more details on this technique.

### **Connection Scheme 2:**

In Figure 2, we add an audio mixer and a 4-channel tape deck. I show them as two separate units in the diagram; however, they could be “combined” into one unit as is the case with most cassette multitrack recorders. The mixer controls the relative volume of each audio channel and also the left/right stereo placement in a stereo mix. Here is some advice: if you are going to buy a cassette multitracker that has a built-in mixer, spring for a unit that allows you to mix at least 2 inputs together at the same time and record to at least two tracks simultaneously. This opens up many more sonic possibilities and technical flexibility than a unit that only has one audio input and can only record to one track at a time. Also, any mixer you buy always seems to quickly run out of channels as you add more equipment to your home studio, therefore, buy the mixer with the greatest number of channels that you can afford.

Figure 2 shows the mixer with a pair of outputs and the 4-channel recorder with a pair of inputs. Some mixers might have master and submaster outputs, giving you a total of 4 outputs. Some 4-channel multitrackers might also have 4 separate inputs, some might have 2 inputs, and some might just have 1 input. If your mixer has an owner manual (and you know where it is!), refer to it for more connection options. (In all of these diagrams, you could (and should if you can afford it) substitute an 8-channel or 16-channel recorder for the 4-channel recorder that is shown.)



**Figure 2: Simple Overdubbing Multi-track Scheme with Mixer**

The big improvement over Connection Scheme 1 is that Connection Scheme 2 allows overdubbing and what is known as track bouncing. The bouncing of tracks allows one to combine several previously recorded tracks onto an open, unused track, thereby opening up the previously recorded tracks for new audio recordings. For example, audio recorded previously on tracks 1,2 and 3 on the 4-channel recorder can be sent to the mixer, combined with a live, real time performance from the synthesizer (or guitar or whatever) and then recorded onto open track 4 on the 4-track recorder. Tracks 1, 2 and 3 can then be erased and new material can be recorded onto them. This is how you can build up more than 4 tracks of audio on a 4-track recorder. When the 4-track is filled up, you can then mix the 4 tracks down onto the 2-channel recorder for a master recording. If you want to add more tracks to that recording, you can record the audio from the 2-track master recording on the 2-channel recorder back to 2 tracks of the 4-channel recorder. This will allow you to effectively start a new song on the 4-channel recorder and you can add two more tracks of overdubs (for example a lead guitar riff and some synthesizer stabs) before you do the final master mix back over to the 2-channel recorder. See pages 251 through 255 in the book for more details on bouncing and overdubbing.

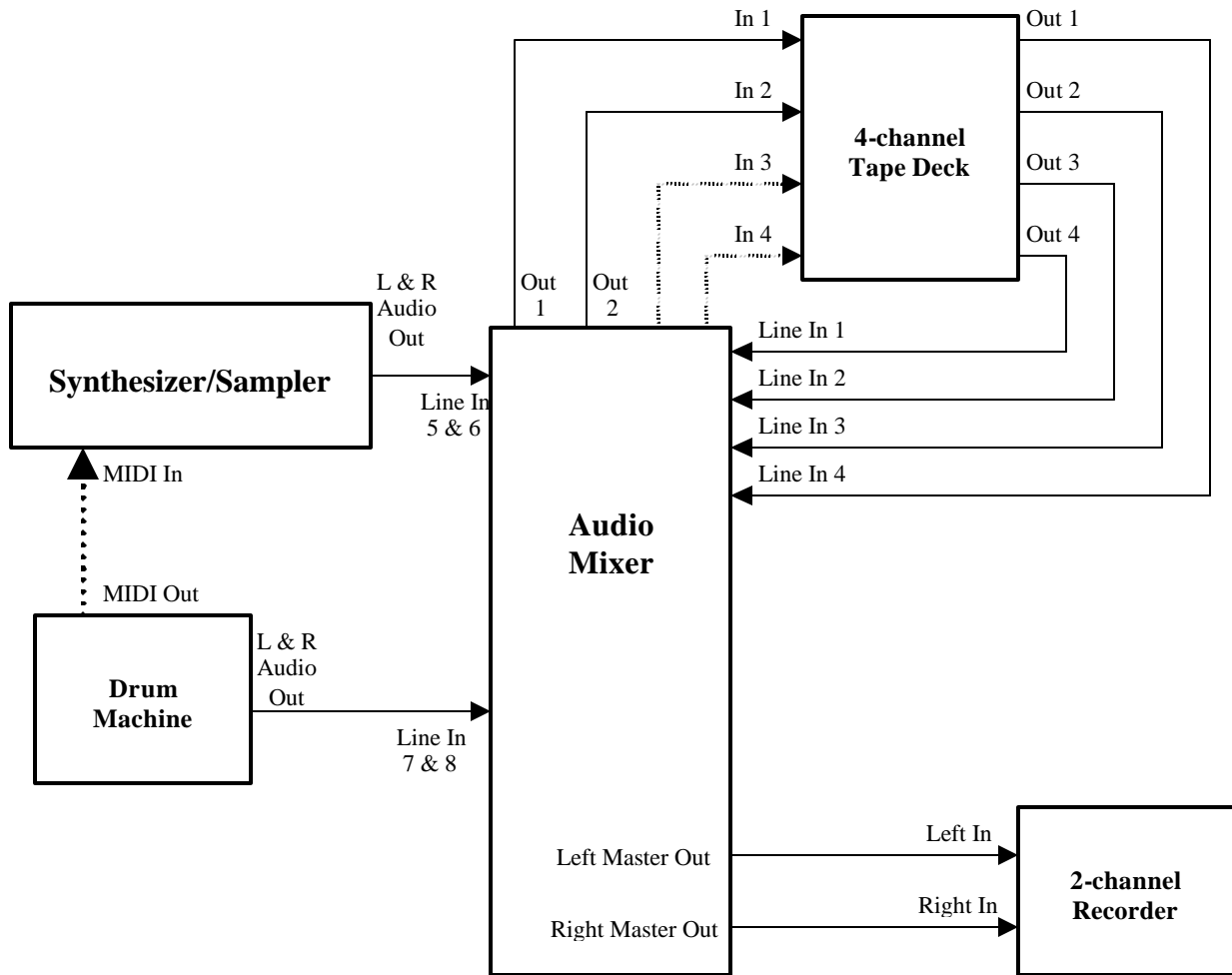
Of course, there are some limitations with this approach. Every time you bounce tracks, you add to the noise floor of the recording. This is especially problematic on cassette multitrackers. Another problem that can show up on analog recorders is that the bass frequencies tend to become over-emphasized during multiple track bounces. You can try to fight these problems with noise reduction processors, equalizers and exciters.

### **Connection Scheme 3:**

In Figure 3, we add a drum machine. For the home studio, a drum machine is a powerful addition. Not only can you add drum and percussion tracks electronically without disturbing the neighbors with a real acoustic drum set, but you can program most drum machines with various drum patterns to construct any type of song from scratch.

The diagram shows the MIDI Out of the drum machine driving the synthesizer MIDI In port. This is so that the drum machine can trigger synthesized or sampled sounds in your keyboard or sampler in perfect sync with the drum patterns playing in the drum machine. You can also layer additional synth sounds or samples on top of the drum machine sounds using this technique. (MIDI (Musical Instrument Digital Interface) is a serial digital protocol that allows one device to control another device or to send configuration or synchronization data to another device. It is electrically similar to the RS-232 bus that is used by computers for some printers and dial-up modems. MIDI signals travel over their own dedicated digital cable with 5-pin DIN connectors on each end.)

I have not shown any sync-to-tape capability in this connection scheme. I will introduce that option later in Connection Scheme 6. Sync-to-tape allows a digital device such as a sequencer or a drum machine to play in perfect sync with tracks on a multitrack recorder. In Connection Scheme 3, we are relegated to recording the drum tracks generated by the drum directly to the 4-channel recorder. In this case, the drum machine serves as the rhythmic basis of the song. You can set the tempo and time signature to be whatever you want on most drum machines.

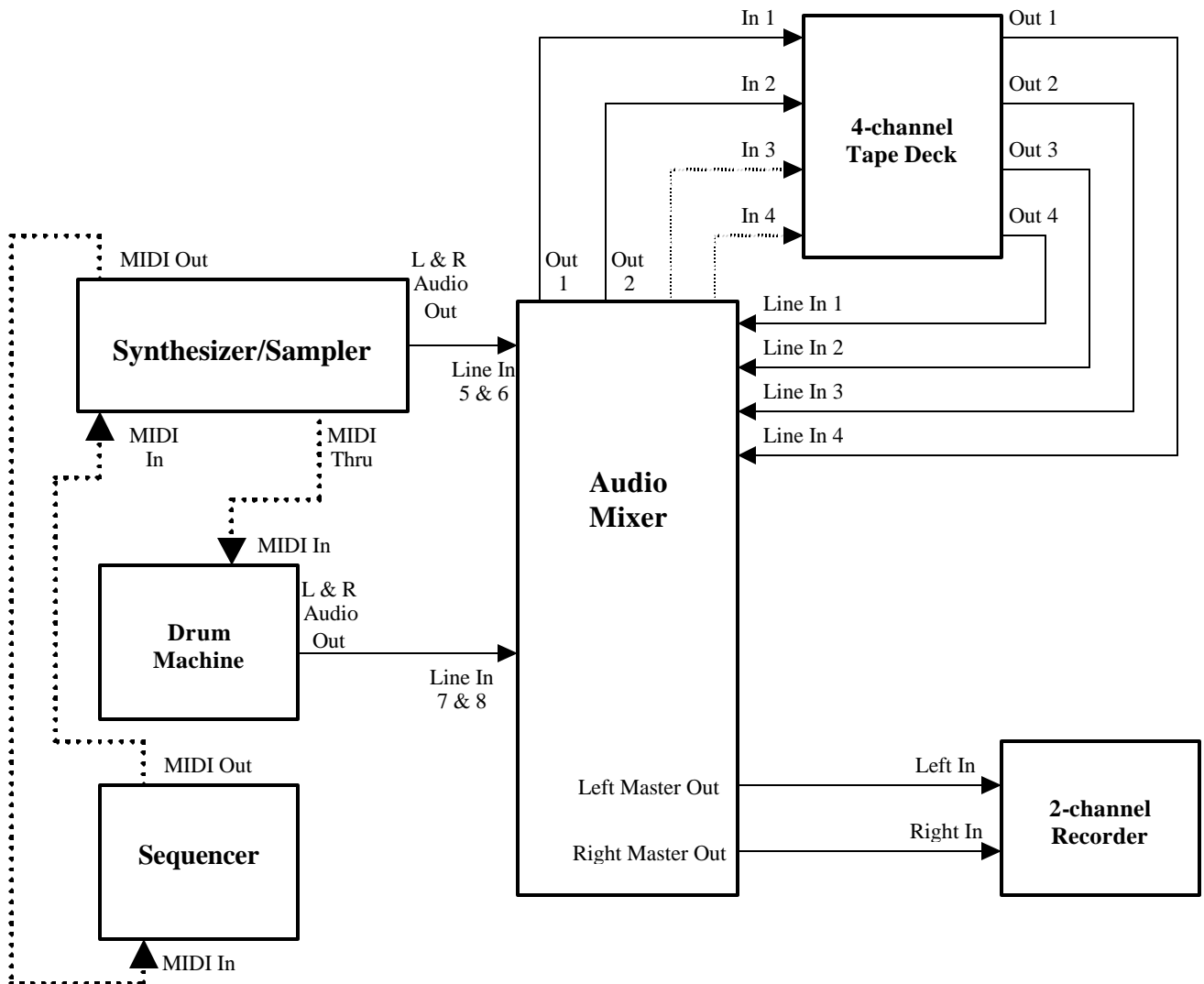


**Figure 3: Addition of a Drum Machine with MIDI**

Once you have programmed the drum patterns into your drum machine, you can put the drum machine into play mode, play the drum pattern sounds into the mixer and mix it with another instrument (a good choice would be the bass). In this fashion, you could record all the drums (from the drum machine) and the bass (from a synthesizer or bass guitar) onto one track of the 4-channel recorder. Now you have the complete rhythm section on one track of the tape, and you have the other 3 tracks to add guitars, keyboards, vocals, Tibetan monk chanting or whatever suits your fancy. After you fill up the 4 tracks, you would then mix them all down to the 2-channel recorder for the master recording. It is always a good idea to plan out in advance what instruments are going to be recorded onto which tracks and in what order. This prevents gnashing of teeth later on in the recording session.

### Connection Scheme 4:

In Connection Scheme 4 (shown in Figure 4), we have added a MIDI sequencer. A sequencer is a special type of digital recorder that records a MIDI performance rather than the actual audio from the performance. These recorded MIDI performances are called “virtual instruments”. A sequencer is used to record which notes are struck on a MIDI keyboard or on drum machine pads, when the notes are struck, how hard they are struck and how they are released, if any pitch bend or modulation is added to the notes, etc. You can buy a standalone hardware sequencer (there are a ton of them on the used market now) or the sequencer can be a software program hosted on a PC or Mac computer. A third option is that the sequencer may be included as part of your multi-timbral synthesizer.



**Figure 4: Addition of a MIDI Sequencer**

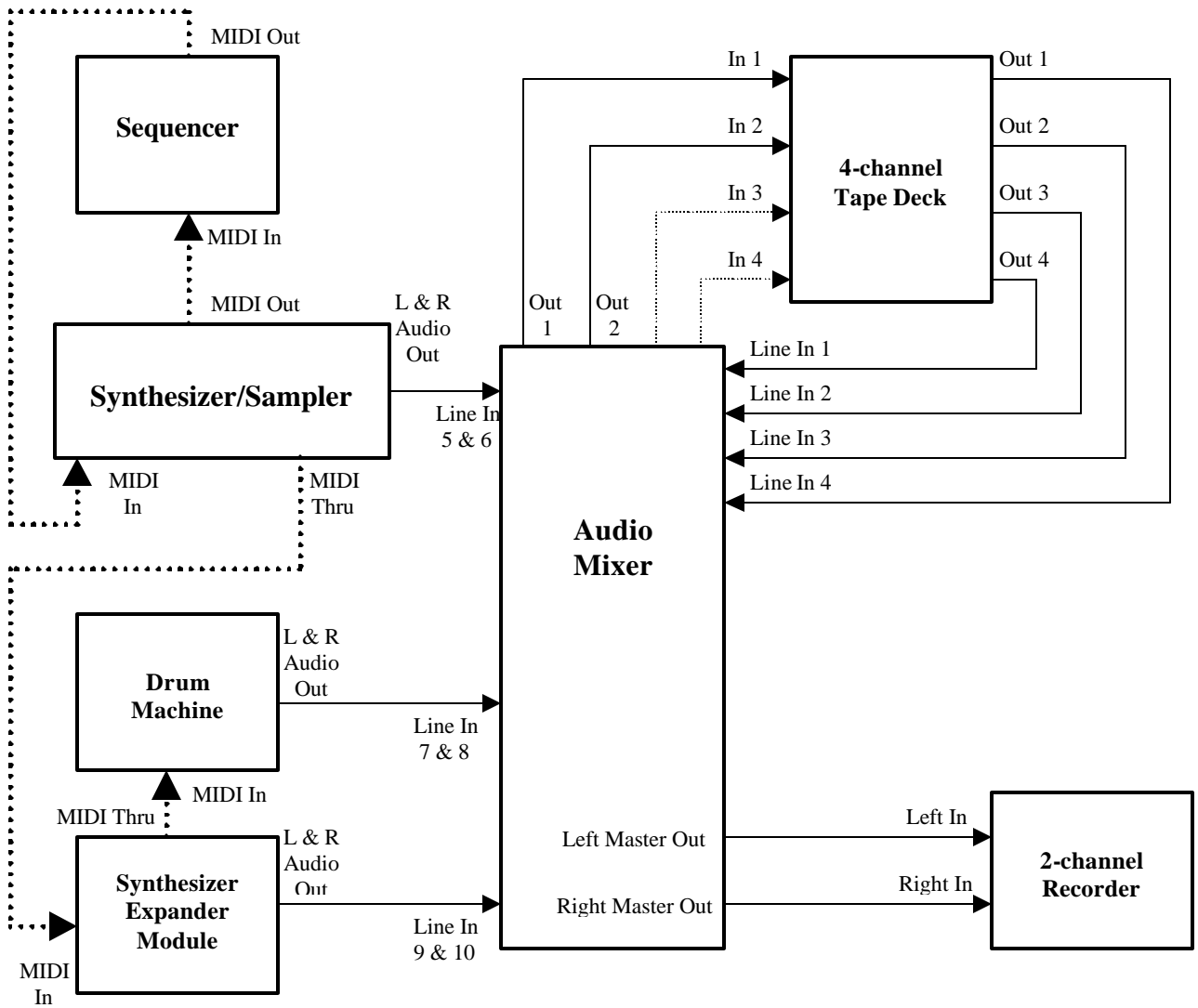
There are many great things about using a sequencer in the home studio. One is that the recording of the MIDI information does not use up any tracks on the 4-channel recorder. There is no tape noise or distortion associated with the data recorded by the sequencer because it is just recording the note data performance. If you make a mistake while playing the MIDI keyboard or drum pads, you can go into edit mode on the sequencer later and correct the mistake so that the correct notes are played back. Finally, you can play back any recordings made on the sequencer with any synthesizer, drum machine or sampler voices you want. You are not constrained to use the same voice you used when you recorded the original sequence. For example, say you recorded a certain horn line in to the sequencer using a trumpet voice, but later on (when you go to mix the song) you find that a French horn voice sounds better. You can simply change that voice on your synthesizer or sampler without rerecording anything.

You can record and play back as many individual, sequenced instruments as your synthesizer/sampler has available voices to use in real time. Perhaps a good strategy for the connection scheme shown in Figure 4 is to use the sequencer as the master synchronization source for the system. The sequencer then drives the MIDI control signals to the synthesizer and the drum machine. I would place the sequencer in play mode and then record all of the MIDI drum and sequenced instruments to 2 channels of the 4-channel recorder at one time, using the mixer to mix them together before they go to the 4-channel recorder. Then I would go back and add vocals or guitars or other acoustic (i.e., non-MIDI) instruments to the other 2 tracks on the 4-channel recorder. Finally, I would mix it down to the 2-channel master recording.

### **Connection Scheme 5:**

In Figure 5, we add a MIDI expander module. A MIDI expander module is basically the same as the electrical circuits of a MIDI keyboard but without the keyboard. The main function of the MIDI expander module is to provide additional sequencer-controlled voices/instruments for the song. The expander modules usually cost less than their keyboard cousins, plus they can be mounted in a rack. The main advantage of adding expander modules to a sequenced MIDI set up is that more voices go to tape in the first generation, rather than adding noise with the additional tape bounces and overdubs described previously.





**Figure 5: Addition of MIDI Expander Modules**

I have shown the MIDI connections from the sequencer MIDI Out to the synthesizer, expander module and drum machine as a series of daisy-chained connections using the various MIDI Thru ports. This approach will work. A better approach that avoids accumulating lag times is to use a 1-In/4-Out MIDI Multiplexer box. These cheap little MIDI processors can take 1 MIDI input signal and replicate it into 4 separate MIDI outputs.

## Connection Scheme 6:

The scheme shown in Figure 6 is extremely powerful for music production because it allows you to synchronize sequenced instruments and drum patterns with audio tracks that are already recorded on the multitrack recorder. Since the synchronizing tone is recorded onto the multitrack recorder, any sequenced instruments that are being played back do not need to be recorded to the multitrack recorder. They can be mixed directly to the 2-channel recorder during the final master recording step and combined with any tracks on the multitrack recorder. This synchronization is accomplished by a device called a tape synchronizer.

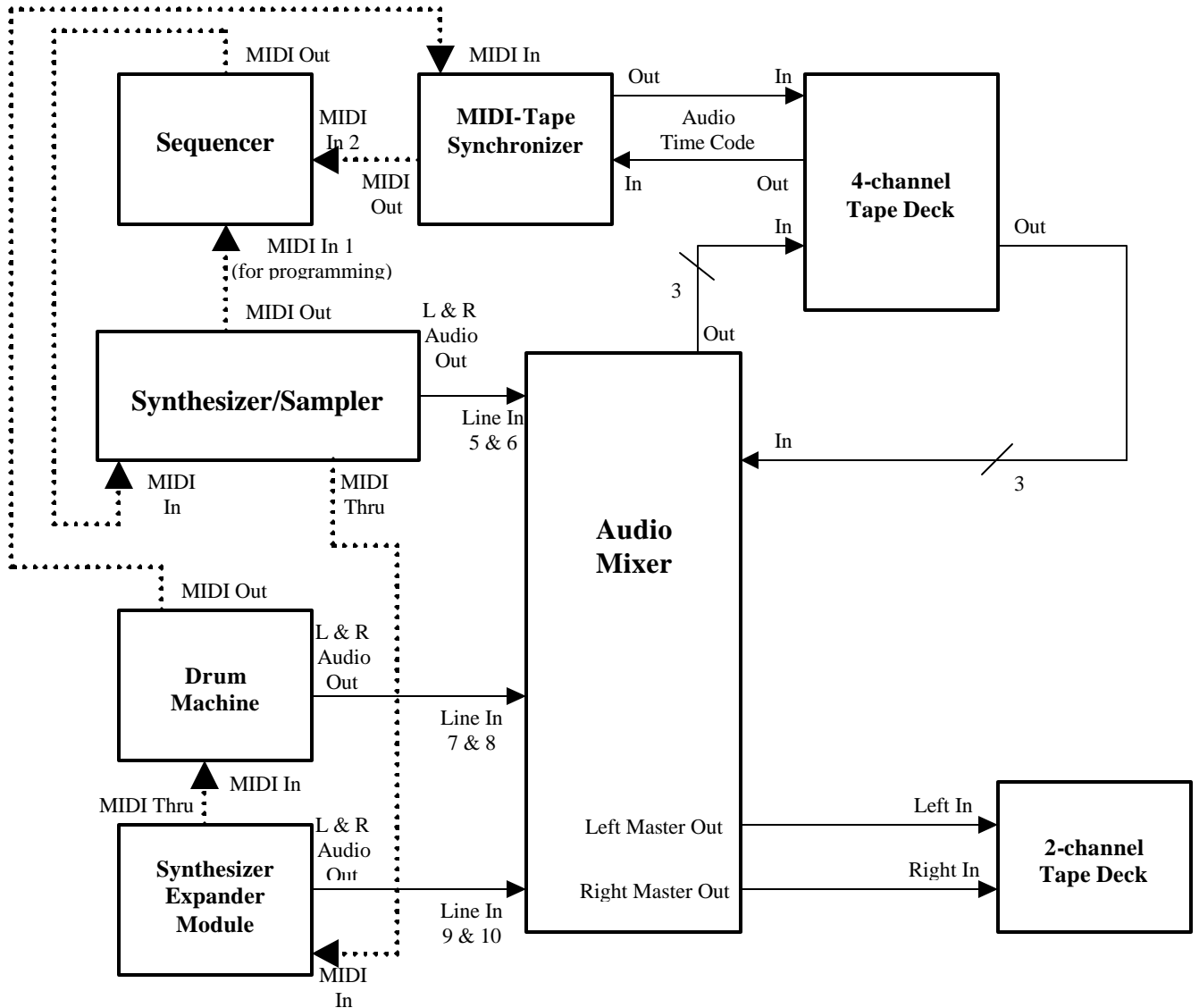


Figure 6: Addition of Sync-to-Tape Capability

Back in the 80s and early 90s, this tape synchronization for home studios was performed by a box that allowed you to record a FSK (Frequency Shift Key) signal onto tape. An example of this type of device was the Yamaha YMC10. The FSK signal consisted of a certain frequency tone to represent a digital ONE and a different frequency tone to represent a digital ZERO. The FSK signal represented a synchronizing count on the tape from the beginning to the end of the song. Drum machines and sequencers could read this audio signal from the tape recorder, decode it and determine what they should play to be in perfect sync with the tape. Usually, the FSK encode/decode circuitry was built right into the sequencer or drum machine. This approach has now given way to the use of MTC (MIDI Time Code) used in conjunction with SMPTE Time Code. See pages 29 and 38 of the book.

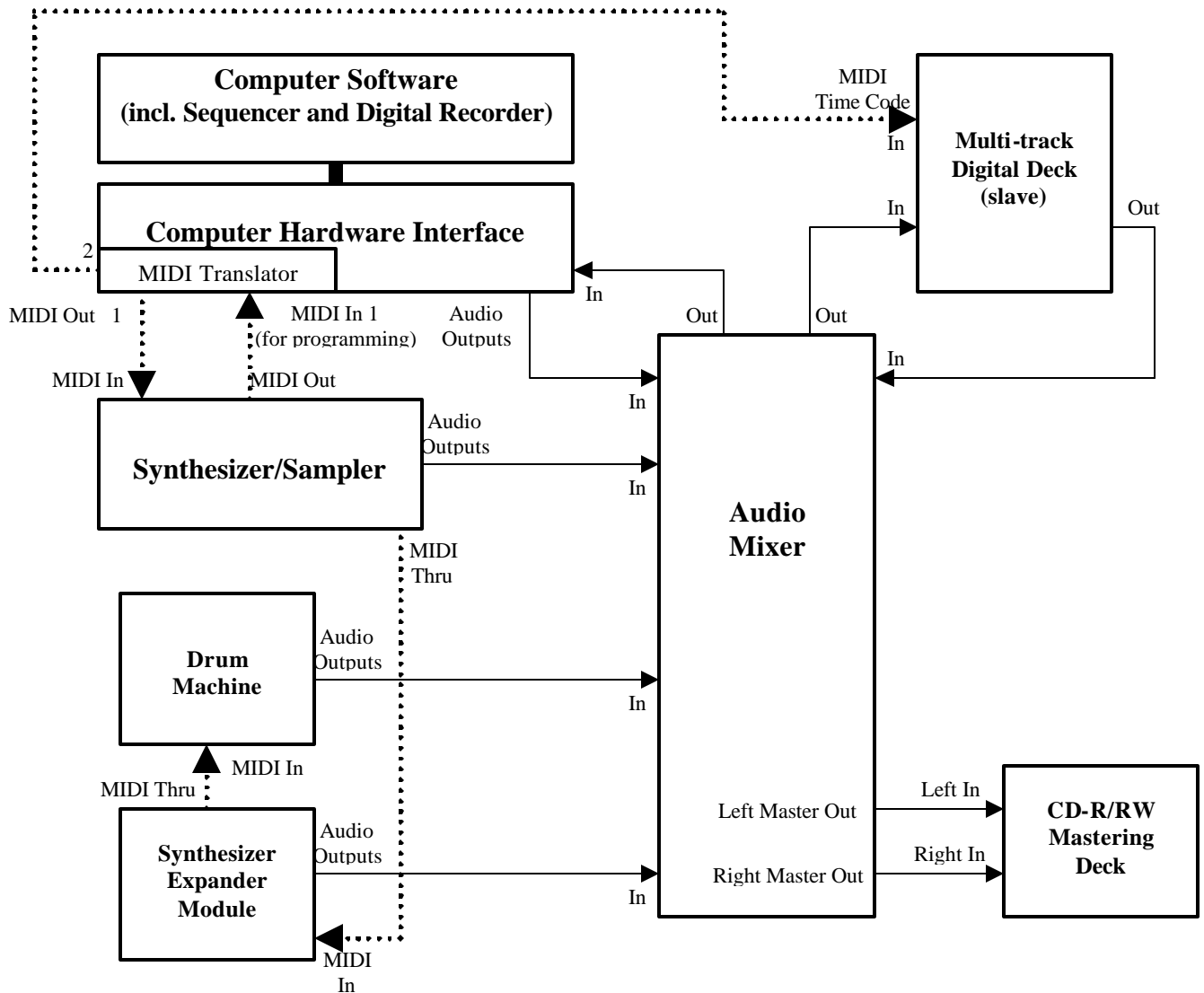
Using the scheme in Figure 6, a SMPTE Time Code signal is first recorded onto track 4 of the 4-channel recorder (or track 8 or 16 of an 8- or 16-channel recorder, respectively). This is generally done by driving the MIDI-Tape Synchronizer via MIDI with a drum pattern (set to the correct tempo and time signature) from the drum machine. This recorded audio signal becomes the master synchronizing signal for the system. The MIDI-Tape Synchronizer later reads this audio signal off of the multitrack recorder and generates the MTC signal that is used to synchronize all of the other MIDI devices (sequencer, drum machine, synthesizers, samplers, etc.) in the system. The MTC signal is sent out of the MIDI Out port of the MIDI-Tape Synchronizer and travels within the normal MIDI cables.

With this scheme, the tracks on the multitrack recorder can be reserved for non-MIDI instruments (stringed instruments, human voices, woodwinds, horns, etc.) and the MIDI instruments can just mixed in with the mixer at the last step as everything is recorded to the 2-channel recorder. Another bonus of this approach is that the song tempo can be slowed down for recording challenging passages by adjusting the pitch control on the multitrack recorder (if there is one available).

### **Connection Scheme 7:**

In Figure 7, we have upgraded the home studio system substantially. The standalone sequencer has been replaced with a computer hosting a software MIDI sequencer application and a software recording application (sometimes these are combined into one application). The 4-channel recorder has been replaced with a standalone multitrack digital recorder. The 2-channel recorder has been replaced with a CD-R or CD-RW digital recorder. This is a completely digital recording system for the home.

The computer offers a flexible and powerful platform to host various audio applications such as sequencing and digital recording. A suitable hardware interface will need to be installed in the computer to allow audio and MIDI signal I/O. The MIDI Translator may be contained within the computer hardware interface box or it may need to be a standalone box connecting to one of the computer's serial ports. (See book pages 39 through 43 and 78 through 82 for information on selecting a computer hardware and software for your home recording studio.)



**Figure 7: Digital Recording System with Computer and Standalone Digital Recorder**

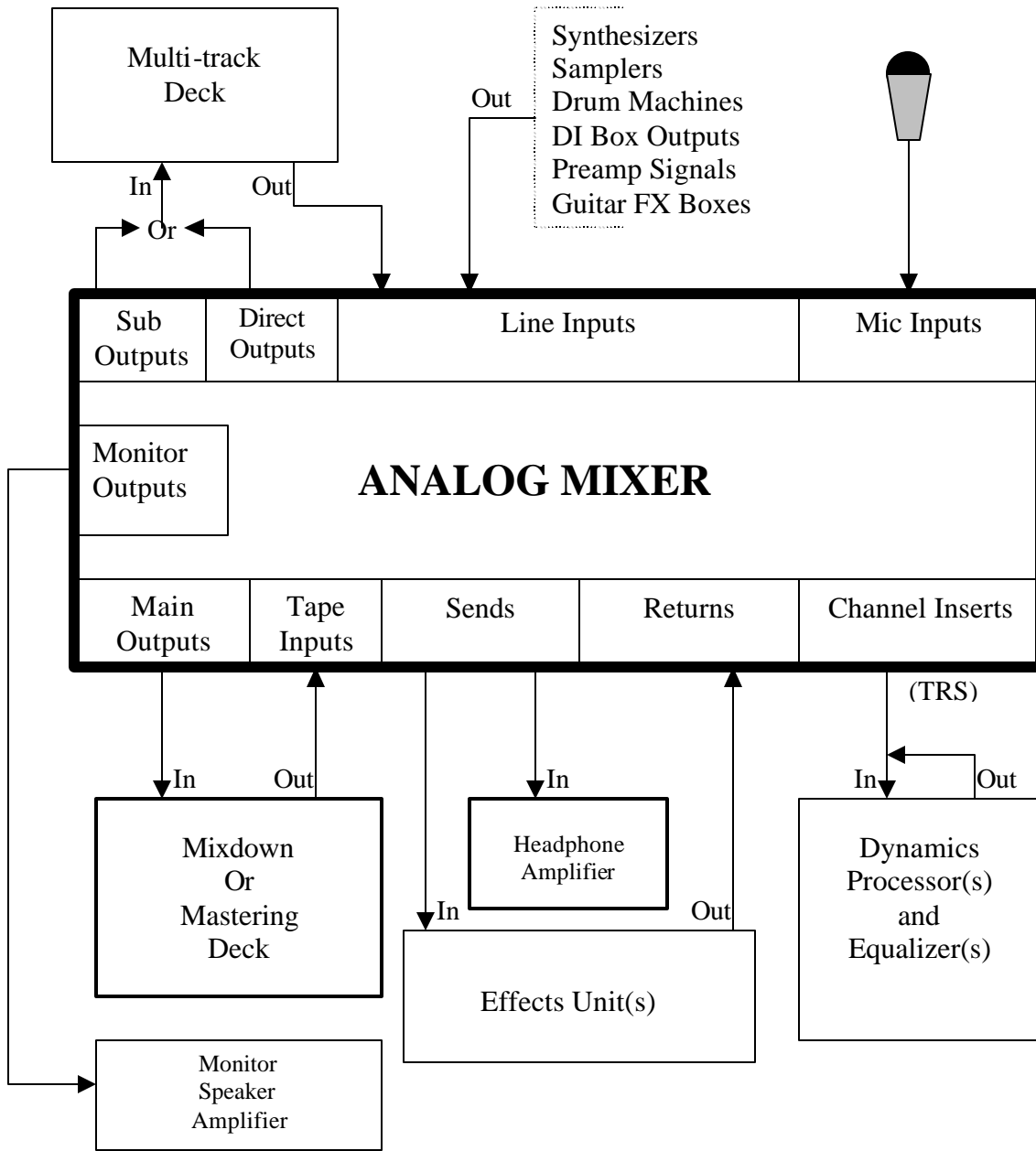
Virtual MIDI instruments can be recorded to the MIDI sequencer in the computer. Actual analog audio instruments and voices can be recorded either to the digital recorder software in the computer or to the standalone digital multitrack. I configured the system this way to show you how to connect a standalone digital multitrack to a computer in case your computer doesn't have enough horsepower to support a digital audio recording application. (The book discusses the minimum computer system hardware you will need to support a digital audio recording application.) MTC from the computer sequencer application is used to synchronize the tracks on the standalone digital recorder. Not shown in the diagram are the digital/analog and analog/digital converters for the standalone digital recorder. Sometimes these are included within the standalone digital recorder and sometimes you have to purchase them separately. It all depends on the model of recorder you buy.

The system can work in the reverse also, if you change the MIDI cables around between the standalone digital recorder and the computer. That is, the standalone digital recorder can be used as the system master and the computer can be configured to act as a slave to that master. In this case, the digital recorder will generate the master MIDI Time Code, that MTC will be sent to the computer, and the computer will synchronize itself to that master time code. Make sure you setup the computer to receive the MTC (the MTC from the standalone digital recorder must be present at the input of the MIDI Translator) and act as a slave, or you will be wondering why nothing is happening on the computer side while the master digital recorder is playing or recording.

This system has the capability to turn out professional quality digital recordings to CD-R or CD-RW.

### **Typical Analog Mixer Connections:**

I have provided this diagram to show the typical signal flow for connecting equipment to a generic analog mixer in a home recording studio. Use this diagram with the text found on pages 92 through 116 and 256 through 270 of the book. TRS refers to a special cable called the Tip/Ring/Sleeve Insert Cable which is required for Insert connections. On the TRS end, the Tip is the Send signal and the Ring is the Return signal. (For an example of this cable, see [http://www.hosatech.com/product\\_page\\_insert.html](http://www.hosatech.com/product_page_insert.html))



**Figure 8: Typical Analog Mixer Connections**