The Sequencer In A Music System

How Do I Send Thee? Let Me Count The Modules.

BY ITSELF, A MIDI SEQUENCER makes a dandy doorstop, paperweight, or bookend. Its reason for existence only becomes apparent when it is hooked up to other devices in a MIDI studio or stage environment. Given the right equipment in the right configuration, and given the right operating software, a sequencer can be used to create music of great complexity and subtlety. The operating software is discussed at length beginning on page 15. Here we're going to take a look at how a sequencer fits into a music system.

The simplest possible MIDI sequencing system consists of a sequencer and a single instrument—usually a keyboard synthesizer or sampler—which is used both for inputting data into the sequencer and for playing back what the sequencer has recorded. (Of course, an audio amplifier and speaker—or headphone—system of some sort comes in handy too.) This bare-bones setup is illustrated in Figure 1. In an extreme case, the sequencer might be built into the instrument itself, as in the Ensoniq ESQ-1 synthesizer. If no other equipment is involved, MIDI isn't being used, so an ESQ-1 by itself isn't technically a MIDI sequencing setup at all. But it amounts to the same thing musically. Besides, all built-in sequencers these days will send out MIDI data, so a MIDI sequencing setup can easily be built up around a single self-contained keyboard/sequencer unit.

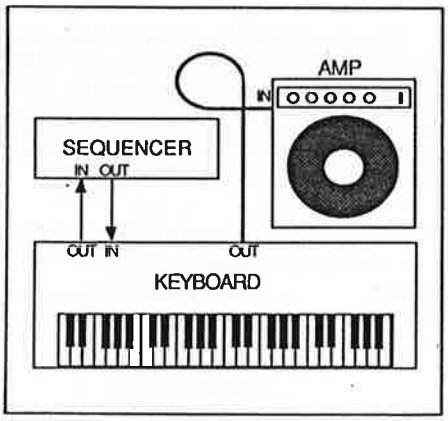


Figure 1. The simplest possible MIDI sequencing system contains only a single keyboard instrument, which functions as both a sound source and a master controller (input device) for the sequencer.

A sequencer can't make any noise by itself. It can only play whatever electronic voices are available in the instrument(s) it is hooked to. If it is hooked to a synthesizer that will generate up to eight notes at a time, then sequences with up to eight-voice polyphony can be created. We can store as many more simultaneous musical lines as we'd like in the sequencer—but the poor eight-voice synthesizer will run itself ragged trying to play them all back at once. And if the synthesizer is capable of playing only one patch (sound program) at a time, then all of the sequencer's notes will have to be played by voices that use this patch. Thus they will all have the same sound.

This point is sometimes not understood by beginners. They begin, let's say, by recording a bass part into one track of a sequencer using something like a Korg Poly-800, whose voices must all share the same patch. Then they switch the Poly-800 to a string sound to record some string chords, and get terribly distraught when the bass part is played back with a string sound. "What am I doing wrong?" they cry. What they fail to understand is that the sequencer doesn't record the *sound* of the bass, only the keystrokes that were used in the bass part. Since the Poly-800 will only play one patch at a time, the sequencer's output must use this, whatever it happens to be at the moment.

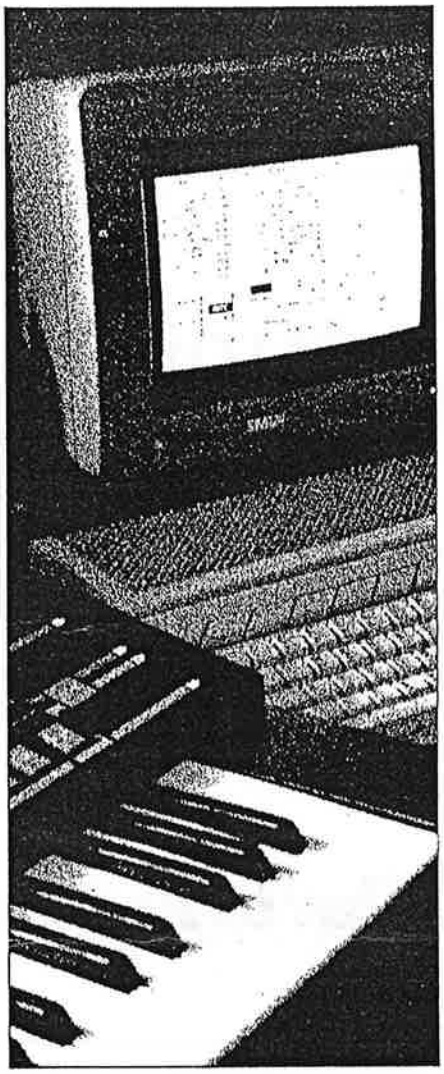
In order to build up musical arrangements containing a variety of sounds, we need either a variety of synthesizers and tone generators, or (more economically) a

single synthesizer or tone module that is *multi-timbral.* A multi-timbral instrument is one that can create multiple timbres (pronounced "tam-brz") at the same time.

If we have several tone modules, each can be set to its own MIDI channel. The sequencer can then send various notes to various individual modules, and each module will create sounds using its own current patch. This hookup is illustrated in Figure 2.

But it's a waste of hardware to use an eight-voice or 16-voice device when all we want to play on that channel is a monophonic (one-voice) bass or lead part. So more and more manufacturers are building multi-timbral, multi-channel tone generators. Such a device is a single module with a fixed total number of voices (such as eight or 16) that can be assigned individually to any MIDI channel, and can use any of the patches in internal memory.

For example, we could assign three voices to channel 1 and have them play an electric piano sound, two voices to channel 5 with a distorted lead sound, one voice to channel 6 with a bass sound, and the remaining two voices (if this is an eight-voice module) to channel 11 with a chime sound. Now this one module can play sequencer tracks with music assigned to channels 1, 5, 6, and 11, and all of the parts will have their own sounds. We can send a program change command on channel 5 at any time, for example, and change the distorted lead sound to some other sound without affecting the sounds being played by any of the other voices. Thus a single eight-voice multi-timbral module can perform a number of different musical tasks in the course of a single arrangement. Alternatively, we could assign four voices



to channel 1 with a piano sound, and another four voices also to channel 1 with a string sound. With this arrangement, each time a MIDI note arrives, two voices (a string/piano layer) will sound, but only four notes can be played at a time.

Multi-timbral keyboards include the Kawai K5, Casio CZ-1, and Oberheim Matrix-12. Multi-timbral tone generators without keyboards include the Oberheim Xpander, the Yamaha FB-01, TX81Z, and TX802, and the Roland MT-32. Most sampling keyboards and rack-mount samplers are also multi-timbral. Even more helpful when it comes to MIDI sequencing, many samplers use *dynamic voice allocation.* Instead of assigning some fixed number of voices to each sound/channel combination, they may allow any channel to use whatever voices are currently not sounding a note. If an eight-voice module has dynamic voice allocation, we could play an eight-note chord on channel 1 followed immediately by an eight-note chord on channel 2. Assuming that it has sounds assigned to both channels, the machine should play all the notes in each chord. The Ensoniq ESQ-1 and SQ-80 and the Kawai K5 are just about the only synthesizers that currently offer dynamic voice allocation, but it's sure to become more common in the future.

Our growing MIDI studio now has a master controller of some sort, a sequencer, and a couple of multi-timbral tone generators. But we're only getting started. Depending on our musical needs and the size of our budget, we may want to incorporate many other types of MIDI-controlled devices. Commands for these can be recorded into the sequencer as part of a song, allowing us an almost infinite variety of automated control over the finished arrangement. We may also need interface boxes of one sort or another in order to get all the parts of our system to talk to one another.

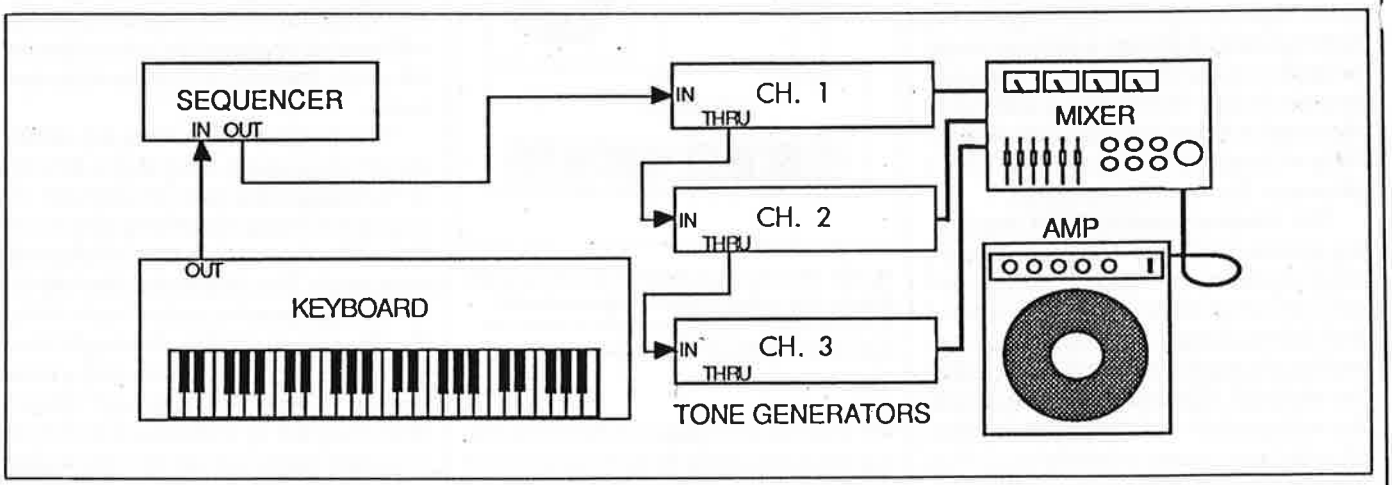


Figure 2. In a typical small sequencer system, a master keyboard (which makes no sound by itself) sends MIDI data to the sequencer. The sequencer is configured so that its output is also a thru port, allowing the master keyboard to talk directly to any of the tone generators. At any given time, the master keyboard will probably be playing one of the tone generators while the sequencer plays the others.

THE SEQUENCER IN A MUSIC SYSTEM

Every MIDI sequencing system is different, but they all include components in some or all of the categories below.

• **Tone generators.** This is by far the largest category of MIDI equipment. Digital synthesizers, samplers, and hybrid designs can be found in all price ranges, from $250 or less for a used Casio CZ-101 or Yamaha FB-01 to half a million for a fully loaded Synclavier. As we mentioned above, a well-equipped MIDI studio will usually have at least a couple of multi-timbral synthesizers and a sampler handy.

•**MIDI controllers.** Before the birth of a standardized digital music language, this whole class of devices would have been unthinkable. They don't make any sound of their own; all they do is generate MIDI data for driving slave modules and sequencers. If you're not a keyboard player, a guitar or wind controller can be the key to unlocking the world of sequencing.

A *master keyboard controller* like the Yamaha KX76 or Kurzweil MidiBoard has a velocity- and pressure-sensitive keyboard, along with a memory for storing keyboard setups that route various regions of the keyboard to various MIDI channels. Because the whole cost of the unit goes toward its performance attributes rather than toward sound-generating hardware, the keyboard may be somewhat better, and the MIDI convenience features more comprehensive, than on an equivalent synthesizer or sampler keyboard.

Acoustic pianos with MIDI sensors under the keys are found in some studios.

Many performance interfaces make use of *pitch-to-MIDI converters.* These devices sense the frequency (pitch) of an incoming audio signal by observing its waveform, and put out the corresponding MIDI note message. This is not an easy conversion to make, for technical reasons, and producing good data on a pitch-to-MIDI converter requires a clean performance technique. Pitch-to-MIDI converters like the Fairlight Voicetracker and IVL Pitchrider also sense the amplitude of the signal, which may be converted into velocity. Microtonal pitch variations may be translated into pitch-bend data.

Guitar controllers come in two forms: Some, like the SynthAxe and Casio MG-510, are designed specifically to generate MIDI data, and make no acoustic sound. Others use a hexaphonic pickup mounted under the strings of a conventional acoustic or electric guitar; the signals from this pickup are run through a bank of six pitch-to-MIDI converters.

Alternate controllers, which may use almost any imaginable physical motion, whether it happens to be "musical" in a conventional sense or not, are beginning to make inroads. Some of the more exotic devices, like Michel Waisvisz' Hands, are available only on a custom-made basis. Others are sold commercially. The Palmtree Airdrums are a pair of sticks, shorter and thicker than drumsticks, with built-in motion sensors that generate MIDI when moved horizontally, vertically, or rotationally. The Fast Forward Designs MIDI Step is a one-octave organ pedalboard.

Why worry about a pedalboard when the subject is sequencing? Isn't that a live performance interface for somebody who has their hands full? Sure it is—but maybe you'd like to do live improvisation to a sequenced accompaniment, and you happen to have a sequencer that will transpose its playback in real time in response to a MIDI note input. Just step on the pedal, and you're in a new key.

• **Computers.** Often, the computer will be functioning as the sequencer. But they're useful for many other things, such as patch storage and editing, and there's no law that says you couldn't use a hardware sequencer for sequencing and keep the computer around for other things—even video games.

• **Drum machines.** A drum machine is a sequencer that is optimized for playing its own built-in percussion sounds. Most drum machines these days will both send MIDI notes when they play a sound and play and record their own sounds in response to incoming MIDI notes. By sending MIDI notes from a drum machine, you can layer the internal sounds with other sounds or record the drum part into another sequencer.

And because the drum machine will receive MIDI notes, you don't need to use its internal sequencer at all. In many cases, recording the drum part as one or more tracks within your main sequencer is a better approach. This lets you store the entire song on a single disk and load it at the next session, rather than having to deal with two different devices' memory. The drawback is that many sequencers aren't as slick at recording typical drum patterns as a drum machine is. One, the Roland MC-500, has a special drum pattern mode that gives you the best of both worlds—single disk storage along with some drum machine recording and song-building features.

Assuming that the drum machine sends and receives MIDI clocks, it can also be used as the master timing reference in the studio. This can be especially helpful if the drum machine will generate its own tape sync tone while the sequencer won't. You can sync the drum machine to tape and use its MIDI clock output to keep the sequencer locked to the tape, whether or not you use the drum sounds. A few drum machines won't transmit MIDI clocks while synced to tape, however, so if this application is important to you, you should learn exactly how the sync functions operate on the drum machine you're looking at before you buy it.

• **Audio effects.** Two types of MIDI audio effects devices must be distin-

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What's In A Voice?

UNFORTUNATELY FOR THOSE OF us who have to talk about synthesizer technology or try to understand it, the word "voice" is being used today in two entirely different senses. Yamaha and some other manufacturers use it to refer to the data in a single patch program; thus, the memory of a DX7 can be said to hold 32 voices, and these can be stored in a "voice cartridge" or edited with "voicing software."

At the time this usage of the term was adopted, however, "voice" had already been used for several years to refer to the output of a single monophonic signal path —the electronic equivalent of a clarinet or tuba, which has one air column. An instrument has eight voices if it is capable of playing eight-note chords with all the notes sounding simultaneously (provided that all the notes can be independently controlled from the keyboard or other input source; if two pitches can be sounded at the same time by pressing a single key, they only count as one voice). By this definition, the DX7 is a 16-voice synthesizer. To avoid confusion, we will use "voice" in this article *only* in the second sense.

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guished—*programmable* and *real-time controllable*. A programmable device has an internal memory in which it stores configurations of front panel settings. These can be recalled instantly by sending the device a MIDI program change command. In a real-time controllable device, the front panel settings can be changed one at a time by sending MIDI controllers or other data to the device. (Most real-time controllable effects are also programmable, and can respond to MIDI program changes.) Real-time controllable effects like the Lexicon PCM-70 tend to be a bit more expensive than straight programmables like the Yamaha SPX90, because more internal operating software has to be developed to run them. But lower-priced units like the Korg DRV-2000 reverb, in which some (though not all) parameters can be controlled in real time, are becoming more common.

The advantage of MIDI-equipped audio effects in a sequencing environment is that automated changes can be made in the sound processing; these changes, being part of the sequence, can be edited and stored on disk. This lets the musician do

all kinds of neat tricks, like adding a longer reverb time to the last high note in a phrase, or suddenly cuing in a delay line to add echoes to a single drum hit.

The MIDI effects that are now available do not always respond to program changes or control changes in as smooth and silent a manner as musicians might prefer. It's quite normal, for example, for a digital reverb to "shut off" the reverberant sound while switching to a new program. Because of this, some care must be used to make changes in the effects at moments when the sound will not be disrupted.

• **Automated mixers and attenuators.** Until a couple of years ago, automated mixing was exclusively the domain of megabucks studios. MIDI has changed all that. For the first time, a musician working in a home studio on a relatively modest budget can do detailed automated mixes using MIDI. The convenience that this affords is inestimable.

Two types of devices are currently available in this category—MIDI mixers and MIDI attenuation systems. The difference is that a mixer accepts a number of audio inputs (such as eight or 16) and provides a two-channel stereo output. An attenuation system provides MIDI automation, but not mixing. If it has eight inputs, it also has eight outputs; these must then be patched into an ordinary audio mixer. Other factors being equal, attenuation systems tend to be less expensive than mixers.

As with effects devices, some mixers and attenuators are programmable and some are both programmable and real-time controllable. A programmable mixer may have a programmable cross-fade time, during which the controls will move from their old values to the ones required by the new program. Cross-fade time may be global (that is, all the programmable settings will be governed by it), or it may be programmable on a per-patch or per-input-channel basis.

Automated mixing poses some special problems in sequencer design. When a tune is started in the middle, the sequencer must be able to update all of the mixer or attenuator channels to the settings that they were given after the last control change, or the music will sound drastically wrong. Nevertheless, just about

any MIDI sequencer can be used with any MIDI mixing/attenuation system, as long as you're willing to do a certain amount of fiddling with the data.

• **MIDI-to-computer interfaces.** Only one computer, the Atari ST series, comes equipped with its own MIDI jacks. All other computers must be equipped with a MIDI interface of some sort in order to be used for sequencing. In general, you should find the sequencer software you want, and then buy whatever interface is recommended for it. Not all interfaces that are designed for a given computer will work with all of the software that runs on that computer, so beware. Some computers have no MIDI interfaces built for them, and thus no MIDI software either.

Some interfaces are very simple, consisting of no more than a couple of MIDI jacks wired into whatever connector will plug into the computer. Others have a variety of features, such as tape sync or SMPTE sync in and out jacks, multiple output jacks to which individual tracks can be assigned, and built-in metronomes. The IBM Music Feature, an interface card that plugs into the IBM PC, even has its own eight-voice synthesizer (a Yamaha FB-01) built-in.

• **MIDI routing devices and data massagers.** As long as you've only got two MIDI-equipped devices, you can connect them with a single pair of MIDI cables and never have to worry about where the MIDI data is being routed. But once you get five or six instruments, you're liable to spend almost as much time peering at their back panels with a flashlight as you do playing music, trying to figure out which jack is the in and which is the thru, and cursing the idiot who thought it was cute to mount the jacks sideways.

A whole host of handy devices has been developed to make life in the MIDI tangle easier. Many of these are programmable; that is, you can reconfigure your MIDI routings by sending a single patch change command to the routing box. A *switcher* has several inputs and several outputs, and lets you send any in to any out. An out can only be fed by a single in, however. To send two ins to the same out, you need a *merger*.

In addition to straight merging and switching, many of these devices perform secondary tasks, such as rechannelizing (also called *channel bumping*, because the number of the channel is "bumped" up or down) and data filtering. Some designs go even further. The Yamaha MCS2, for example, has built-in wheels and sliders for generating and sending controller information.

At the high end, the Axxess Unlimited Mapper will perform many types of data translation, including things like turning a single key into a programmable chord.

• **MIDI-to-CV interfaces.** Remember all of that old analog synthesis gear you've got stashed on the shelf in the garage? Want to do a little MIDI sequencing with it? Several items of equipment are available that convert MIDI data into a form that a Minimoog or ARP 2600 can use.

One of the most versatile is the Roland MPU-101, which will receive monophonically on four channels or polyphonically on one channel and put out control voltages, gates, and key velocity values for each of four notes, as well as global voltages (one each for the whole unit) for pitch-bend amount, modulation amount, and channel pressure. It can even be used to divide MIDI clocks by various factors to sync up an arpeggiator or analog sequencer.

Built-in MIDI modifications are available for some older instruments.

• **Synchronization devices.** If routing MIDI data, which is all in a single electronic format, poses occasional challenges, getting devices to talk to one another when each sends and receives a different type of sync signal is often a nightmare. The various sync codes are discussed on page 44. If your sequencer and drum machine don't speak the same language, and the tape deck won't listen to either of them, or if you're trying to sync the sequencer to something *really* weird like a human being, you'll need a sync box.

The simplest sync boxes are devices like the Yamaha YMC-10, which does nothing but translate FSK into MIDI clocks and vice-versa. If your sequencer (like many Atari ST software sequencers) only understands MIDI clocks, you'll need something of this sort to get it to sync to tape. Nearly as affordable, and lots more convenient, are newer units like the JL Cooper PPS-1 and SynHance MTS-1, both of which send time-stamped FSK tones that let the sequencer chase-lock to the middle of a long tune (assuming that it can receive song position pointer).

Garfield Electronics has specialized in synchronization interfaces, from their first Doctor Click to a whole line of devices with specialized uses. The Garfield Master Beat and the Kahler Human Clock are both designed to translate an audio pulse, such as the sound of a snare drum played into a microphone, into MIDI clock data. More sophisticated devices like the Master Beat, the Garfield Time Commander, and the Roland SBX-80 allow the user to define a "tempo map" of tempo changes, or to generate one themselves by memorizing an audio pulse coming from a tape track. And then there are the SMPTE sync machines. . . .

Synchronization is far too complex an application for us to deal with it in detail here. It's beginning to look as if time-stamping of some sort is going to become nearly universal within a couple of years, but that doesn't mean that older, simpler systems are useless. It's still possible to make fantastic music with simple means; you just have to put out a little extra effort.

• **Everything else.** Non-MIDI equipment is not prohibited from darkening the threshold of a MIDI studio. You're liable to find anything from a microphone or electric guitar to a VCR. Also optional is a musician. Not optional is a teetering stack of owner's manuals. □

Troubleshooting

IT HAPPENS TO US ALL: YOU HIT the sequencer's play button, and nothing happens. No sound. There can be lots of different reasons for this. Often, in the course of tracking down the trouble, you'll find not one problem but two or three. In the interest of happier sequencing, here are some of the things you should check:

—Is the computer's MIDI interface switched on?

—Are all of the MIDI cables routed correctly?

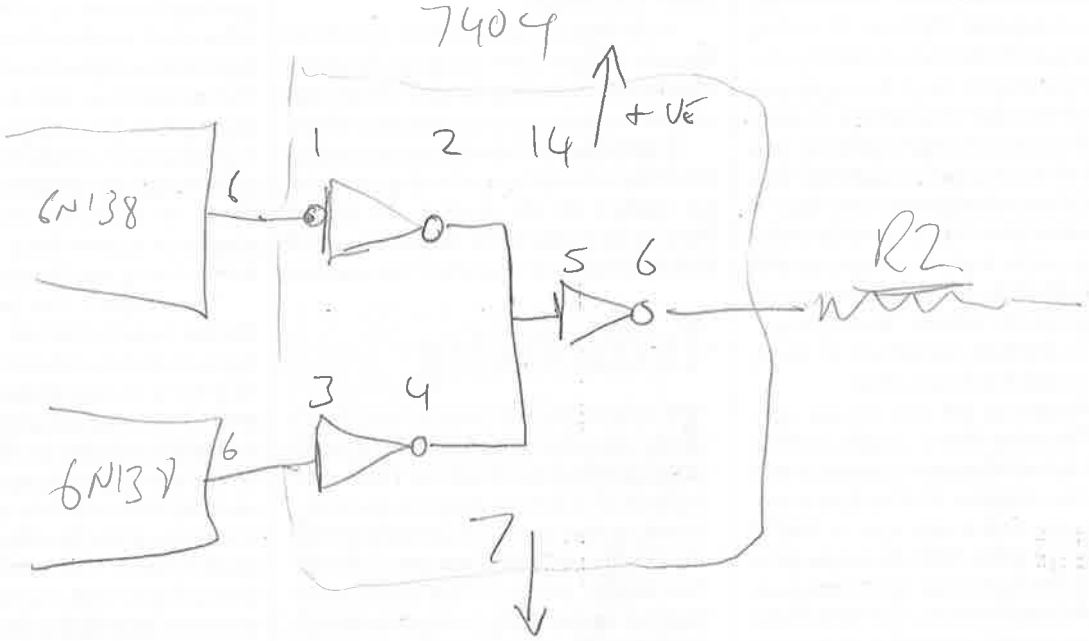
—Is the MIDI routing device sending the sequencer data to the right output? Is it filtering any of the data?

—Is the receiving module set to the right channel? Does it have voices assigned to that channel?

—How about the audio signal path? Is the module's volume turned up? Is it plugged into the mixer? Is the mixer channel turned up? Is the amplifier?

—Is there anything on the track? Is the track unmuted?

—Is the sequencer set to external clock control? If so, is it receiving clock signals?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