The MIDI Music Revolution

An introduction to what MIDI is all about, musical instruments that use it, and how musicians are exploiting this new frontier

By C.R. Fischer

Ever since Thaddeus Cahill's invention of the "Teleharmonium" in 1895, electricity and electronics have played an ever-increasing part in the creation of music. Innovations like the tape recorder, electric guitar, and music synthesizer have provided musicians with endless possibilities for delighting audiences. Another recent innovation—just five years old—has already been the cause of great changes in the way musicians create and perform their work. Widely known as the Musical Instrument Digital Interface, or MIDI for short, it has become the industry-standard interface that allows musical instruments, audio equipment and other devices to be combined into a unified system.

If you use a computer or play a musical instrument, you may have heard about the exciting new world of MIDI. Having heard about MIDI, you may be among the large number

of people whose interest has been deterred by the lack of entry-level information on the subject. If so, this article addresses that shortcoming. Here we'll discuss the MIDI standard, instruments and devices that use MIDI, and how musicians are exploiting MIDI on-stage and in the recording studio.

Ensoniq's Model SQ-80 Cross Wave Synthesizer is just one of the sophisticated MIDI music synthesizers modern musicians use today.

The Model EPS is a state-of-the-art Performance Sampler from Ensoniq offers excellent MIDI implementation with synthesizer and record/playback capabilities.

MIDI Then & Now

Before the MIDI specification went into effect in 1983, musicians working with electronic musical instruments faced a less-than-ideal task. There were no standards that permitted them to combine their instruments to make up a "system." Though a few manufacturers of electronic musical instruments had designed simple interfaces that allowed their own products to be linked together, these were ignored by other manufacturers, who usually claimed that their own designs were superior. Consequently, before MIDI came along, chaos reigned.

By 1982, all but the simplest of music synthesizers contained at least one microprocessor, that powerful little integrated-circuit "chip" that has made possible the current revolution in microcomputers. It was the microprocessor itself that provided the motivation for manufacturers to develop a standard interface for all makes and models of electronic musical instruments. Around this time, a number of U.S. and Japanese companies had begun discussing the idea. After numerous proposals, counter-proposals, disagreements and at least one withdrawal, the basic MIDI 1.0 specification was finally decided upon. This specification was released in August 1983.

This specification was originally written with music synthesizers in mind. The idea was to allow a musician to control a number of "slave" instruments from a "master" keyboard. It's interesting to note that if MIDI had been left at this basic level, its widespread acceptance would have been doubtful. Thus, it has been the additions and enhancements to the specification made in the original version that has made MIDI so useful to today's musicians.

At the outset, the idea of MIDI was greeted with less than overwhelming approval from the music industry. Since the specification was so new and few musicians had any idea of its possibilities, most manufacturers bothered to add it to their products only as an afterthought, and some interfaces had been so poorly designed that they were worthless to the serious user. Another problem was that, because of the two-language nature of the specification, a translation problem between English and Japanese versions led to more than one manufacturer implementing the standard incorrectly. These early disasters led many insiders to the assumption that MIDI wasn't workable and was useless to professional users.

Fortunately, most of these mishaps were ironed out within the first year MIDI was in existence. Many of the software and hardware bugs in instruments were fixed so that, by 1985, MIDI had been established as a *de facto* standard in the music busi-

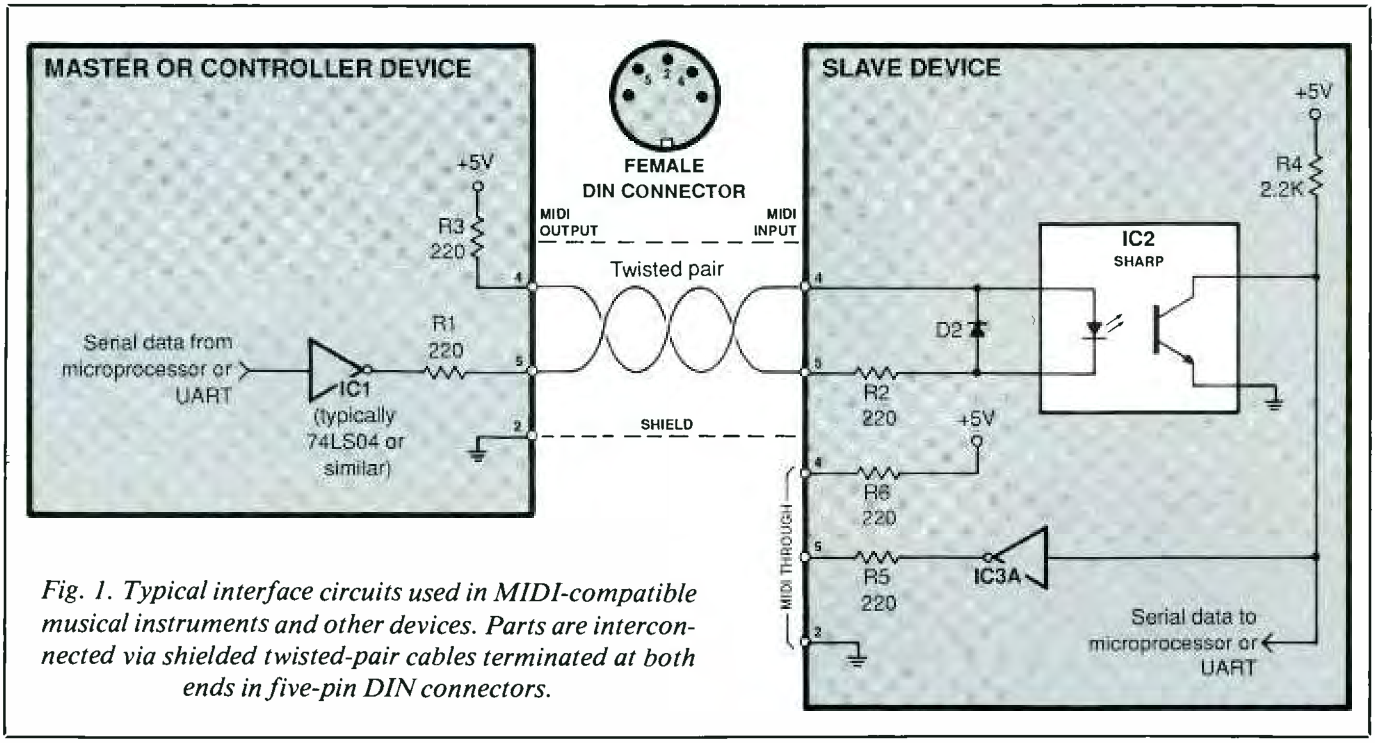

Fig. 1. Typical interface circuits used in MIDI-compatible musical instruments and other devices. Parts are interconnected via shielded twisted-pair cables terminated at both ends in five-pin DIN connectors.

ness. Some of the many instruments and other devices that use MIDI include:

- *Music Synthesizers.* As has already been mentioned, the original MIDI specification was created with a strong prejudice toward electronic music synthesizers. Software commands permit these instruments to be played from an external controller, such as a remote keyboard or sequencer. The controller, as its name implies, controls the notes played, desired program (sound patch), and expressive features like pitch bend and modulation wheels.
- *Samplers.* While synthesizers create sounds using analog or digital sound generators, samplers actually record and replay audio signals using digital recording techniques in a manner similar to that used in compact-disc players. This technique permits musicians to recreate acoustic-instrument sounds, natural sounds and special effects with incredible fidelity. Samplers are also popular for their ability to manipulate these sounds in a variety of unusual ways (the "stuttering" voices heard in radio and TV commercials are created in this fashion). Using MIDI, these sounds can be played from a controller much like a synthesizer.
- *Effects Devices.* Signal processors are used extensively in the recording studio and on the concert stage, as vocals and instruments alike usually require some form of electronic enhancement. There are dozens of processing techniques available, from simple equalizers and compressors to highly sophisticated digital reverberation units and exotic devices for creating special effects. The cost and effort required to manage a number of dedicated devices, however, can present serious problems to the user.

Instead of having to market a variety of specialized processors, manufacturers can now build multi-purpose effects boxes from which the user can select or edit the desired treatment using MIDI control. This capability offers a number of advantages, not the least of which is that instead of having to buy a variety of specialized units, the user need only a smaller number of generic devices. Since the manufacturer could now carry a more abbreviated product line, the lower production costs also led to lower retail prices. Finally, MIDI commands allow a musician or recording engineer to switch between various effects as desired, such as echo on the verse, reverb on the chorus, and flanging for a solo instrument.

- *Sequencers.* One of the most exciting applications of MIDI is the recording of musical performances with perfect fidelity and flexible editing. The sequencer is a device that records MIDI data that represents a musician's performance. Once the data has been recorded, it can be manipulated in many ways that aren't possible with simple tape editing.

As an example of the above, a song can be recorded at very slow tempo to make up for a musician's limited technique. After recording, the song can be changed as required. If a few notes had been played out of rhythm, the sequencer can "quantize" the notes to correct their timing. Other editing functions permit notes to be added, changed and deleted. Because no audio signals are being recorded, only digital data that represents a performance, sounds can be changed instantly without the need for re-recording.

Sequencing has become one of the most important uses of MIDI. It's not uncommon for a lone musician to use a sequencer and several MIDI'd instruments to record an entire album at home. Individual parts are recorded and edited until the results are perfect, at which point, the musician brings his or her sequencer and instruments to a recording studio, where the results are recorded in just a few hours time! The savings in studio time and money are substantial.

• *Computers.* Personal computers play a central role in MIDI setups. With the proper interface and software, a computer can perform many useful tasks. For example, a computer can serve as a professional-quality sequencer as described above. Another use of the computer is as a patch librarian that stores hundreds or even thousands of synthesizer sound programs known as "patches" on a floppy disk. Similar programs allow the user to edit and modify these patches while viewing the result on the computer's video display monitor. Still other programs print MIDI data in traditional musical notation for other instruments and copyright purposes.

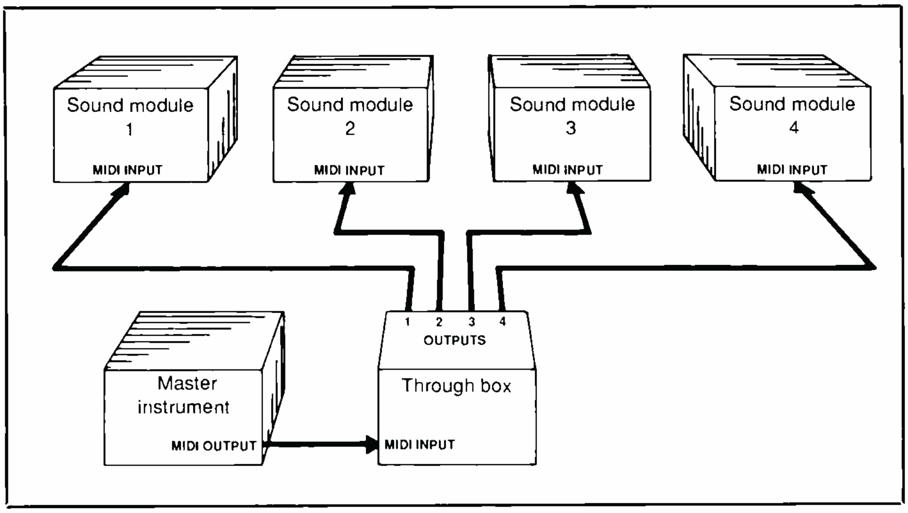

Fig. 2. A number of sound modules, including synthesizers and samplers, can be assigned to individual MIDI channels. By changing the transmitting channel of the master controller, various sounds can be instantly selected.

MIDI Circuitry

Hardware used in MIDI circuitry is straightforward electronics, thanks to the wishes of manufacturers for low cost and simplicity in design. To receive or send data, devices typically use two or three serial ports that are operated at a fixed transfer rate of 31.25K baud. These ports are commonly referred to as "MIDI Input," "MIDI Output" and "MIDI Through," depending on which function they are to perform.

Shown in Fig. 1 is a schematic diagram of the data path that exists between two MIDI devices. Data from the master instrument's microprocessor is converted into serial data that is then buffered by hex inverter *IC1*. This buffering isolates internal components to prevent loading and external short circuits, while *IC1* is able to supply adequate current for reliable signal transfer. Resistor *R1* limits the inverter's output current and also serves to protect the inverter from short circuits and excessive voltages that might arise as a result of wiring errors.

At the slave instrument, incoming data flows in a current loop through *R2*, optical isolator *IC2* and *R3* to return to the master instrument. Current through this loop causes the light-emitting diode (LED)inside *IC2* to turn on and cause the internal transistor's collector to be brought to ground. With the LED off, the transistor's collector is pulled high by *R4*. Diode *D2* protects the optoisolator from damage as a result of reverse-polarity connection. This diode doesn't conduct under normal conditions. Though this design is inexpensive and reliable, it can drive only one MIDI Input at a time.

To remedy the drive limitation, a third type of connector, called MIDI Through, appears on a number of devices. This port simply buffers incoming data at the optoisolator to allow multiple devices to be connected together in "daisy-chain" fashion. The problem with this approach is that connecting multiple devices in series with each other results in a slight delay time in each optoisolator to accumulate, eventually resulting in an audible delay. A preferred solution, therefore, is to use a MIDI Through box designed to drive multiple MIDI ports from a single optical isolator, thus minimizing any delay.

The MIDI specification calls for five-pin DIN-type connectors as standard. These connectors are inexpensive, reliable and widely available. Pins 4 and 5 connect to the current loop, as illustrated in Fig. 1. Pin 2 connects the cable's shield conductor to circuit ground on the instrument that is sending data to prevent ground loops.

Cables that carry MIDI data must be shielded and consist of twisted-pair conductors that exhibit low resistance and capacitance. While the original specification permitted cable lengths of no more than 50 feet, many instruments can drive longer-length cables of high quality with no difficulty.

MIDI Software

Software commands used in MIDI were chosen specifically for their use to musicians and radio engineers. Because music relies heavily on emotion, as opposed to the black-and-white world of digital logic, a great deal of thought went into allowing expressive parameters to be set via MIDI. The original designers of the specification realized that defining every possible command would only hasten the obsolescence of MIDI. Therefore, they wisely left a good deal of room for future developments.

MIDI data is sent in 8-bit packets, or bytes. Most commands require two or three bytes. To increase the number of possible messages, two categories of bytes exist: status and data. Status bytes tell a receiving device how to interpret the data following their arrival. In this case, the two types of messages that can be defined by the status byte are channel and data messages.

Channel messages are used to tell instruments to play or release notes; change programs (patches); transmit the force used whenever a key is struck (velocity) or finger pressure is applied to a key after a note is down (pressure sensitivity or aftertouch); and transmit patch bends and modulation (vibrato and other effects) to increase the musician's expressive capabilities.

Channel messages can be sent to specific instruments by placing each slave instrument on a specific channel (which can be done from 1 to 16). This causes each slave instrument to respond to data only on its specific channel. Whether you prefer rock, classical or other music, you'll notice that each instrument in a group has a specific part to play. Channel messages allow MIDI to do the same thing. Some sophisticated sequencers may have four separate MIDI outputs, each of which has 16 channels. This can be used to control up to 64 individual musical instruments or other devices.

Data messages are not channelized. They are used to control devices in real time. Among these commands are: the start, stop and timing messages that permit multiple sequencers to remain synchronized; song select that requests a sequencer to play a specific selection; and system-exclusive commands.

While most messages are understood by all MIDI instruments, system-exclusive commands are assigned to specific instrument models. This permits two instruments of the same type to send sound patches and other data to each other as well as allow computers to act as patch librarians or editors that allow users to edit and store large numbers of patches on a single computer disk. Creating sounds on a synthesizer using its front panel is often a lengthy, tedious job; use of a computer makes the task a more pleasant one.

Since the original MIDI specification appeared in 1983, a number of additions and enhancements have been implemented. Some permit guitars, horns and other instruments to be used as MIDI controllers as an alternative to the keyboard. A sampler data dump standard for sending the large amounts of data used by samplers via a MIDI link has enhanced the standard. A very useful addition is the MIDI Time Code (MTC) that permits synchronizing music and sound effects to SMPTE time codes used in audio and video work and controls tape recorders and other studio equipment.

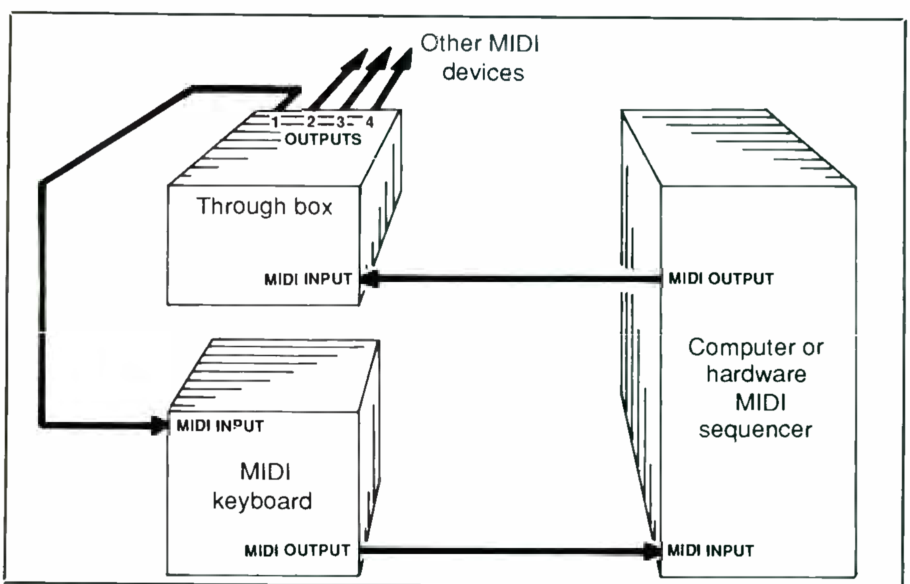

Fig. 3. Combining a MIDI controller, computer- or hardware-based sequencer and one or more MIDI modules forms a powerful tool for musical composition and performance. The controller and sequencer can record and play back a number of separate musical parts simultaneously, allowing a single musician to become a true "one-man band."

(Continued on page 94)

The author at work in Solar Wind Studios, a small San Francisco Bay Area recording studio that specializes in MIDI sequencing and recording. An Atari 1040ST computer controls up to 32 tracks of MIDI's instruments simultaneously.

Typical Applications

Now that you have a basic understanding of how MIDI works, let's look at some of the ways musicians use MIDI on-stage and in the studio. The simplest application was illustrated in Fig. 1, where a master instrument controls a slave instrument. The combined sounds are "thicker" and more complex than either instrument would produce by itself. Many of the sounds used in today's music employ this method, which is known as "layering."

A variation of this technique is illustrated in Fig. 2. Here, a master controls a number of slaves using the MIDI Through box. By assigning each module to a different channel, different modules can be selected simply by changing the controller's channel.

Since a number of instruments have been designed to serve as master controllers, these allow multiple-channel data to be sent at one time or allow the musician to set up specific areas of the keyboard to transmit data on different channels. This is especially useful in concert work, where a musician might need to access a variety of different sounds while playing a single song.

Adding a computer or software sequencer greatly increases the musical possibilities of the system illustrated in Fig. 3. Here, the controller can be used to play the sound modules directly or to input data to the sequencer. The recorded data can then be edited as already described, and individual parts can be assigned to various modules. This leaves the performer free to play along or improvise against the sequenced parts, thus creating a true "one-man band."

In five short years, MIDI has dramatically changed the way many musicians view, create and perform their art. Giving this amazing start, it's virtually a sure bet that MIDI will continue to influence—and ultimately dominate—the music of tomorrow.

LETTERS

One More Turn

• In Fig. 1 of my "The MIDI Music Revolution" (April 1989), it appears that a turn of the twisted-pair wire lines was omitted, causing pin 4 of the OUT port to connect to pin 5 of the IN port, and vice-versa. According to the official specification, pin 4 always connects to pin 4 and pin 5 always connects to pin 5. Also, the positions of D2 and the LED in Sharp PC-900 optical isolator IC2 must be reversed for the circuit to operate. Finally, the MIDI "through" port is almost universally referred to as a "THRU" port in books and magazines. While the "through" spelling is correct, it's a lot easier to read the simpler spelling when one is leaning over several pieces of gear and is trying to figure out why his setup isn't working as it should.

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