Would you like a stereo Mirage with about 6 dB less noise? It only takes a few parts, a little bit of time, and the expertise provided in the following article.

The Stereo Mirage

BY DON SLEPIAN

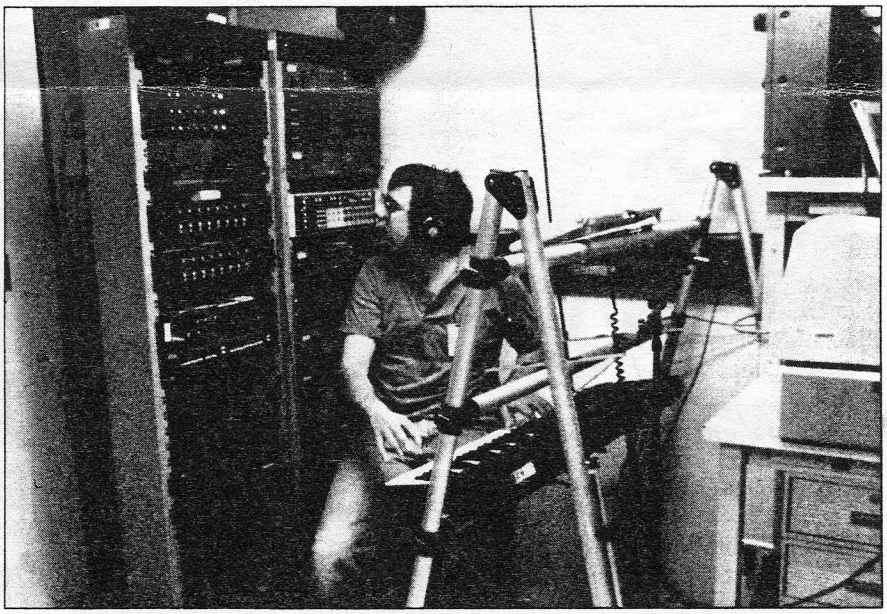
This simple modification to the Ensoniq Mirage Digital Sampling Keyboard takes less than one hour, costs less than $5, and makes an enormous improvement in the instrument for any application.

The analog section of the Mirage comprises eight separate signal processing "modules"—one per voice. My modification groups these eight channels into two discrete stereo outputs that are available simultaneously with the instrument's existing monaural output. I use the old monaural output as an effects send, and route the two new outputs into my stereo mixer.

PROS AND CONS

There are four advantages to this modification. First, the Mirage in stereo is absolutely glorious. I had to fight with myself to write this article, because the improvement is so drastic I was tempted to keep it all to myself! Due to the way the Mirage's 6809 microprocessor scans the keyboard and assigns voices to the eight new discrete outputs, a simple musical scale has the notes flying back and forth across the stereo field. Second, there's a noticeable improvement in the Mirage's signal-to-noise ratio, even when the signals are mixed back to mono. Folks, the hiss is gone! By bypassing the final VCA and summing circuitry in the Mirage, the perpetual quiescent hiss that used to pervade my system is now at a quarter of its former strength—a noise reduction of over 6 dB in both old and new Mirages. Third, there is a distinct improvement in the perceived clarity of sounds, especially in thick or complex layered timbres. In one test, I took the two stereo speakers and placed them on top of each other and listened at a distance so that I knew I was getting absolutely no stereo effect. Upon comparing the sound of the two speakers receiving discrete signals to that of the same signals mixed monaurally, the improvement in clarity was obvious. I don't understand this effect, and my best guess is there is some psychoacoustic difference between mixing sounds electronically and having those same sounds come through different loudspeakers and mix acoustically in the air (see "An Acoustic Mixer" by Terry Fryer in the August '86 **EM**). Fourth, you now have the convenience of hearing the sounds you are sampling through the Mirage's outputs as you sample. This has considerably simplified my sampling setup.

There are also four drawbacks to the modification. First, as the Mirage is powered-up and loads its operating system, it makes eight chirping sounds when its microprocessor issues a clarion wake-up call to each of the eight channels of analog circuitry, and the Curtis VCFs tune themselves up. This comes out at full volume, and would be rather frightening to an audience if you were to power-up your Mirage into a loud PA system in the middle of a gig. I have gotten into the habit of waiting 20 seconds before I turn on the keyboard mixer after first applying power to the Mirage or rebooting its operating system. Second, the volume control on the instrument has no effect on the two



Don Slepian at work and at play.

***Don Slepian** has recorded the album* Reflections *on the Audion label, distributed by JEM Records. When he is not surrounded by Mirages, he plays alto recorder and classical guitar.*

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new outputs. Since I use the old mono output as an effects send, I can use the instrument's volume slider to control that send. Do not mix the old factory output directly with the new ones, since it is out of phase. Third, for performing musicians to take advantage of the beautiful stereo effects and the increased clarity, they must add a speaker and amplifier channel to their stage setup, or run the band's PA in stereo. The old mono Mirage output could be used as a monitor send. Of course, you could just mix the two new outputs together and leave your set-up unchanged—this way you can enjoy the hiss reduction on stage, and leave the stereo effects for the studio. Fourth, you will void your warranty, and companies aren't responsible for carnage you inflict on your instrument in the name of improved performance.

The theory of the mod is really quite simple. The output of each Curtis CEM-3328 VCF (located at pin 9) is buffered with its own internal op amp follower. Just check that no DC offset is present (or AC couple the output), isolate the signals with a bit of resistance, and send the outputs to the outside world.

Necessary Parts and Tools

I don't recommend this mod as your very first project, but if you have successfully built a few kits, this should be easy. You will need the following tools:

- ✓ Set of Allen wrenches
- ✓ Small Phillips screwdriver
- ✓ Roll of electrical tape or heat shrink tubing
- ✓ Drill with ⅝-inch bit
- ✓ Low-wattage (25 Watts or so) fine-tip soldering iron
- ✓ Rosin core (*not* acid core) solder suitable for electronic construction.

You will also need the following electronic components:

- ✓ Two mono open-circuit phone jacks (Radio Shack part #274-280 or equivalent) preferably with nonconductive plastic shells
- ✓ Eight 10K ¼-watt resistors (two packs of Radio Shack #271-1335 or equivalent)
- ✓ A small spool of light gauge wire, or an 18-inch or longer piece of ribbon cable (eight conductors minimum, ten if you don't have any light gauge wire and need to strip two wires off the ribbon for the ground connections described below; try Radio Shack #278-772).

What you're going to do is connect the wires to each of the Mirage's eight analog outputs, use the resistors to construct two separate four-channel passive mixers, and then connect the outputs of these mixers to the female phone jacks, thus creating the new stereo outputs.

Precautions!

Internally, the Mirage is a delicate and complex instrument. The moment you open it up you are on your own. I am not liable for any consequences of your actions. If you're not willing to be completely responsible for your results, then don't attempt this mod! Take precautions against static electricity, don't eat or drink while working, don't allow any distractions, work slowly and carefully, and finish the entire job in one session.

If you are working on a keyboard Mirage, you will have to remove the keyboard. Note carefully the orientation and exact placement of the keyboard ribbon connector on the Mirage motherboard. On my ancient 1984 model Mirage the cable was oversized for the receptacle and offset by one hole. Whatever it is on yours, be sure to study it carefully during disassembly so you can reassemble it properly. Notice also how the keyboard cable is tucked underneath the keyboard. If you don't tuck it in properly upon reassembly you will end up putting a mounting screw right through the cable (as I did on my first attempt).

Performing The Mod

The instructions below are for modifying the Ensoniq rack. Aside from some physical differences, the mods are electronically identical.

My approach is to build everything necessary for this mod first, then install it into the Mirage. There is only one slight difficulty. The Mirage, like most digital instruments, has several different grounds.

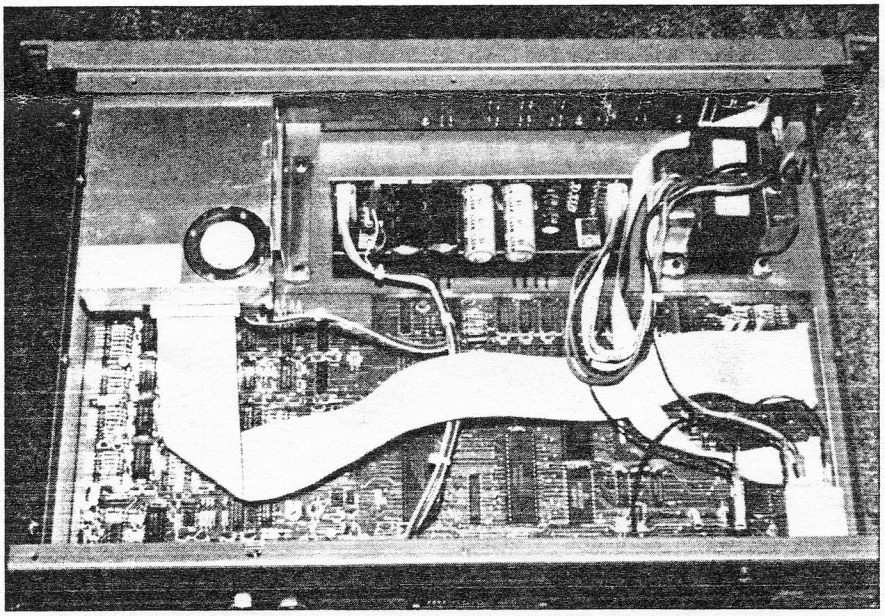

PHOTO: DON SLEPIAN

Fig. 1 *The Mirage rack with the top removed.*

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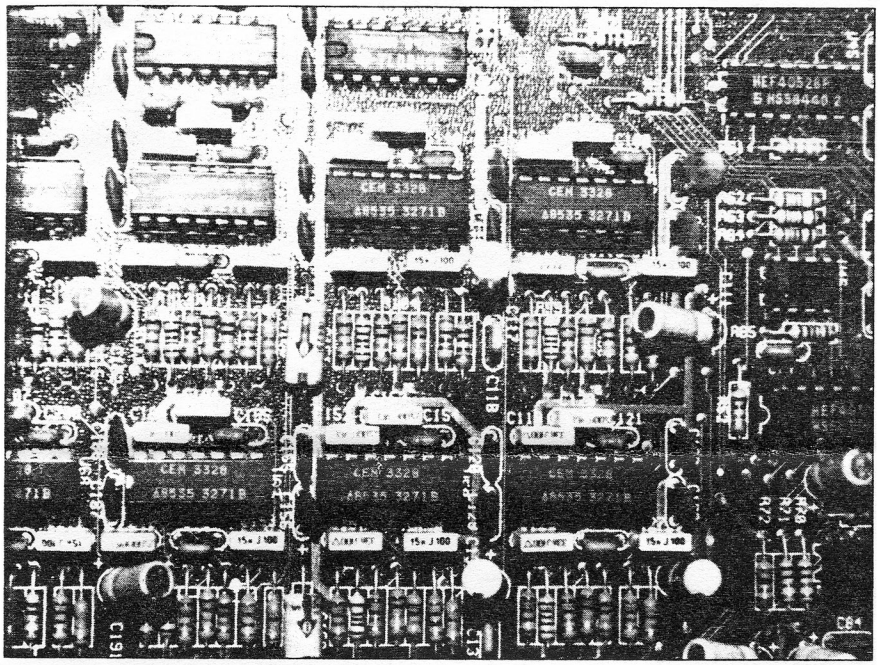

Fig. 2 *The analog section of the Mirage; note the CEM3328 VCF chips.*

The instrument's metal case is connected to the power supply ground, and the digital and analog circuitry each have independent grounds. The two female phone jacks that will become the new stereo audio outputs *must not make any electrical connection to the instrument's metal case.* If you can find female phone jacks with nonconductive plastic shells (as used in the Mirage) your troubles are over; I mounted the two jacks on a sturdy piece of plastic, then mounted the plastic onto the Mirage's case. An easier but less physically secure solution would be to use in-line phone jacks (Radio Shack #274-340) that hang out of the back of the instrument. You could also use an XLR Jack or your choice of many other non-standard connectors to get around this problem.

Before you open up the Mirage, take one of the ¼-inch phone jacks and locate its ground lug connection. Use a thin piece of wire (or separate one wire from the ribbon cable) and solder a six-inch length to the ground lug. Next, take four of the 10K resistors and cut all their leads to ½-inch. Solder all four resistors to the other ("hot") lug of the phone jack. Cut an 18-inch length of the ribbon cable and separate off a four-wire strip. Solder each wire to one of the unconnected ends of the four resistors. Wrap these connections in electrical tape, or heat shrink tubing if you're so inclined.

Prepare the other phone jack similarly by mounting the remaining four resistors and ground wire. Solder the ends of the resistors to another four-strand strip of the ribbon cable. Now we are ready to open the Mirage rack and install the modification.

Remove the top cover by removing the 12 screws with a 5/64-inch Allen wrench (**Fig. 1**). Carefully remove the cables to the disk drive and front keypad, and draw a map of their orientation and placement. Also remove the power cable (Molex connector) and write down its placement. Remove the nuts on the Audio In and Audio Out jacks, and the six black Phillips-head screws (with their star washers) that hold down the main circuit board. Locate the eight CEM3328 ICs (**Fig. 2**). These are the VCFs where we'll be getting our signals. Find the notch at the top of the chip and refer to the top-view pinout (**Fig. 3**) to locate pin 9. Since I found no convenient place to connect to this pin on top of the circuit board without soldering directly to the IC (a risky practice), I removed the circuit board and made the connections to each CEM3328 pin 9 from the underside. Double check that you are attaching the wires to pin 9, and keep your connections tiny and neat. Make sure you have not dripped any solder before remounting the board.

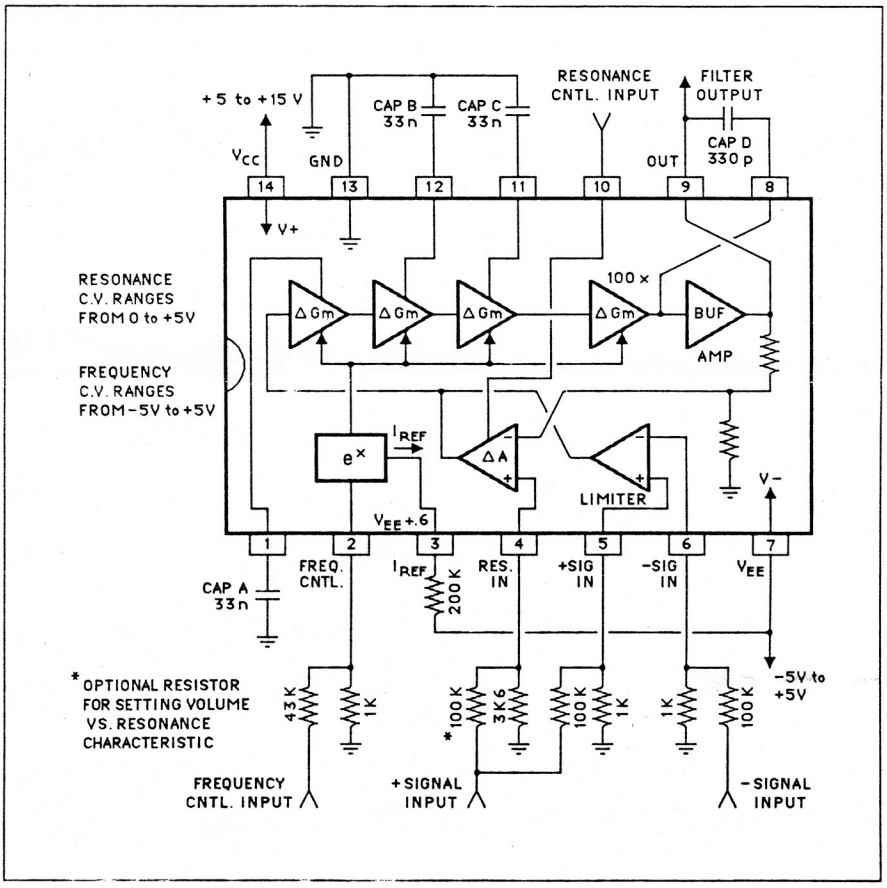

Fig. 3

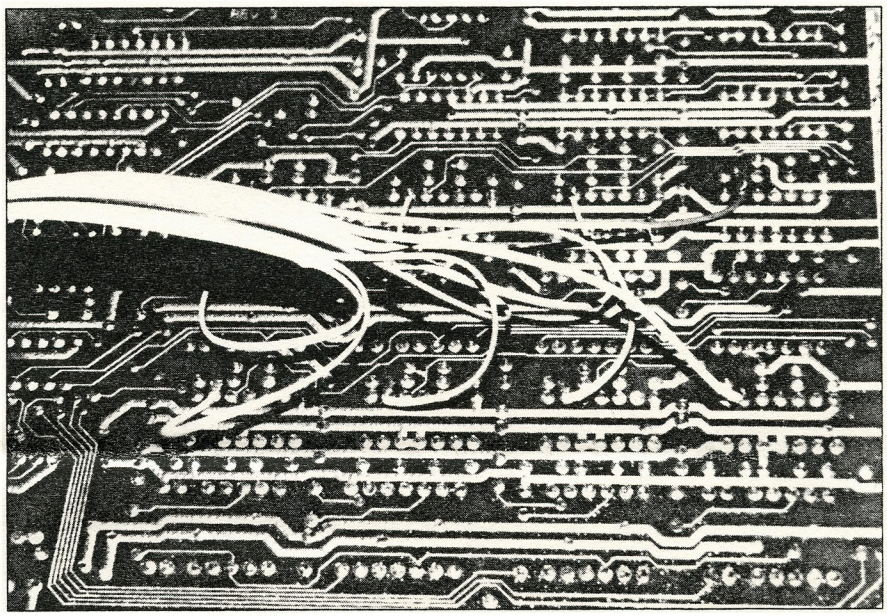

PHOTO: DON SLEPIAN

Fig. 4 *The ribbon cable connects to pin #9 of the CEM3328 filters on the underside of the board.*

The Smoke Test

Now reinstall the circuit board and all the connectors that fit on it. Take the wires that connect to the ground lugs of the phone jacks, and solder them to the metal mounting clips on the top of the audio out jack on the Mirage circuit board. At this point you should check your work. First, turn on the Mirage and verify that the old audio output jack works. Play a two octave scale and make sure all the notes sound. Then connect the two new jacks to your mixer, pan them to full stereo, and turn down the old output (set the Mirage's volume slider all the way off). Play a scale again and check that each note sounds. If any notes are missing go back and check your connections. If all is well, mount the new stereo outputs ***(make sure they make no electrical connection to the case),*** and close up the Mirage.

Going All The Way

There are some other possibilities for this mod. First would be to use an active op amp mixer rather than a passive resistor network, as you lose about 9 dB of gain across the passive mixer. Using a good op amp, your signal-to-noise improvement over a standard unmodified instrument could be better than 12 dB, just by virtue of maintaining unity gain and avoiding that 9 dB output drop. I would recommend the SSM2134, a super low noise improved replacement for the 5534 standard op-amp. Write to Solid State Micro Technology for Music, 2076B Walsh Avenue, Santa Clara, CA 95050 or call them at 408/727-0917 for details on this chip. Bipolar power is available from the power supply connector in the center of the Mirage circuit board.

"How about driving the CEM3328 VCF's differential signal inputs (pins 5 and 6) with an external audio input?"

While you're at it, you could tie into the Mute logic line (available at the final VCA or the volume control slider) to mute the sound of the filters tuning themselves up. If you do this, include a switch to defeat the mute logic during sampling so that you can still audition samples as you make them.

Another simple option is to connect eight output jacks directly to pin 9 of the VCFs before going to any summing circuitry. In the studio, these eight independent outputs could all go to different processors, in effect making a homophonic sound from the instrument be-

come polytimbral. Onstage, the best possible approach would be to route the outputs to eight separate channels of amplification. Let these speakers surround the audience. When I spoke with Tom Metcalf, the sampling wizard at Ensoniq, he imagined the eight outputs panned evenly across the stereo field, with a single knob to control the amount of stereo spread.

How about driving the CEM3328 VCF's differential signal inputs (pins 5 and 6) with an external audio input? The audio could be distributed to all eight VCFs (or stereo audio could be split and fed to four VCFs each) for some rather awesome MIDI-controlled filter processing. You could then put selective filtering and resonating effects directly under the control of your MIDI sequencer software without having to buy another piece of equipment. It might also be interesting to mix external audio with the Mirage's own wavetable oscillators as they go into the VCFs. Imagine being able to blend real acoustic feedback into an electric guitar sample! Yes, the Mirage could be quite a powerful MIDI-controlled effects box.

Another possibility is driving the control input (pin 2) with external control voltages. Hmmm, eight VCFs, perfect for generating barberpole filter illusions with my PAiA Shepard Function Generator...

If you get into this level of experimentation, I recommend removing the CEM-3328s from their sockets and using 14-pin DIP Jumpers to connect them to a new circuit board, where you can place all these optional functions under the control of CMOS analog switches. Good luck, please send me a cassette of the music you make, and don't forget to write to the people at Curtis Electromusic Specialties, 110 Highland Avenue, Los Gatos, CA, 95030 (tel. 408/395-3350), for the CEM 3328 data sheet, applications notes, and their latest catalog of wonderchips. Tell them you get these crazy ideas from reading **EM**.

Postscript: The Roland MKS-10 "Planet P" electric piano MIDI Module, a discontinued product, is being sold for $200 at some discount stores and even less second-hand. I think it sounds very pretty, and the price is right. It is actually a 16-voice synth, and separate outputs for each of the 16 voices can be found on pin 12 of the 16 IR3109 chips on the top motherboard. Happy Stereo Synthesis.

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