

Disappointed because you wanted stereo outputs and didn't wait to buy a Mirage DSK? Don't worry—you can retrofit your existing Mirage for stereo outputs and enjoy the benefits of a fuller, richer sound.

# Stereo Mirage—The Sequel

BY BOB YANNES  
WITH TOM METCALF

We have received a number of inquiries in response to Don Slepian's January 1987 EM article on modifying the Ensoniq Mirage for stereo output. Ensoniq recently introduced the Mirage-DSK, which incorporates a different stereo output circuit that we at Ensoniq prefer as a modification to the Mirage. As a service to Mirage owners who want to modify their units, we would like to provide the information necessary to install our circuit. Please note that this article is provided for informational purposes only. The circuit does not represent a factory-authorized modification (such as the original noise reduction and bandwidth modification kit for the Mirage). Unauthorized modifications such as this, and any modifications performed by unauthorized service personnel will void your warranty!

## POTENTIAL CIRCUIT PROBLEMS

We recommend this modification over Don's for a number of reasons. The circuit presented in his article uses passive mixing through resistors. This results in significant signal loss at the output, due to the voltage divider created by the resistors. In addition, the high output impedance (10 k $\Omega$ ) will interact with the im-

**Bob Yannes**, who wrote the article, was a driving force in the design of the VIC 20 and Commodore 64 computers and designed the C-64's sound chip. After leaving Commodore, he helped found Ensoniq and develop the Q-chip, the heart of the Ensoniq Mirage. **Tom Metcalf**, who figured out the resistor values and wired the prototype, developed most of the Ensoniq sound library and is an expert on sampling with the Mirage.

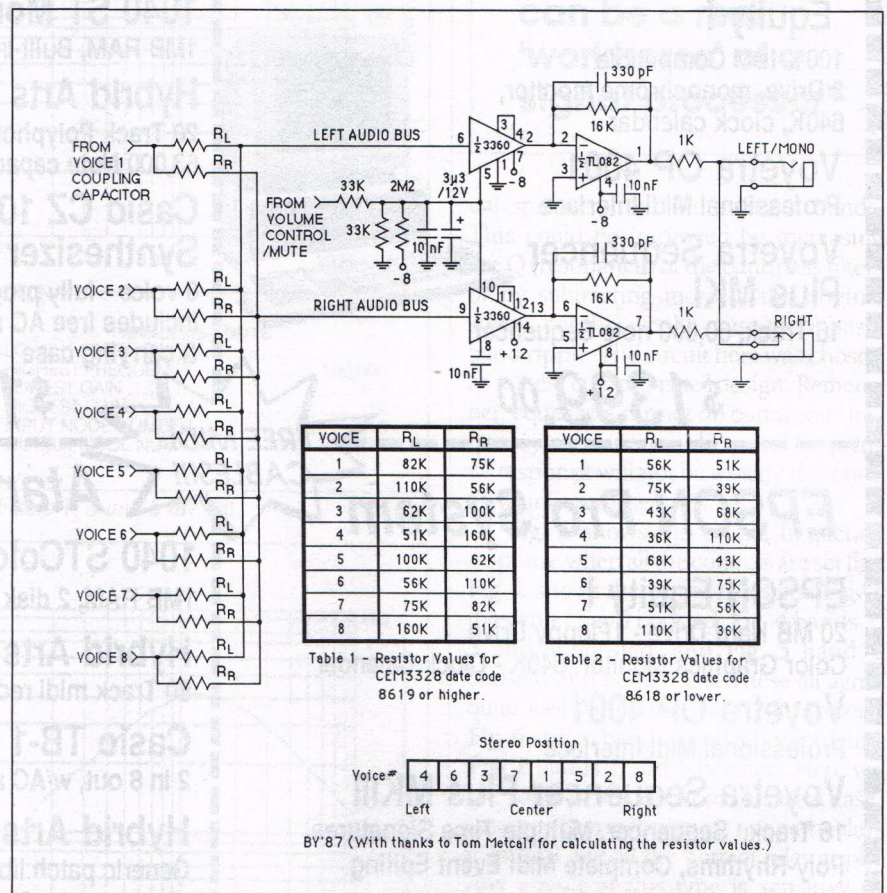


Fig. 1 Mirage Stereo Output

pedance of line inputs, producing different levels when plugged into different mixers and other inputs. This makes it difficult to achieve the best possible signal-to-noise ratio.

The circuit includes no output buffering. Ideally, a signal output should be a low impedance source with output protection circuitry to prevent damage to internal components in the event that improper voltages are applied. Don's circuit taps the signal directly from the Curtis Electromusic CEM3328 filters, leaving

the mixing resistors as the only output protection. The mixing resistor forms an output impedance higher than we feel is desirable, and also, the filters have no special output protection circuitry and potentially can be damaged. We have seen printed circuit boards on which the output traces were vaporized by high voltage occurring when musicians plugged their keyboards into improperly grounded audio systems. Think what that voltage could do to the filters—all eight of them!



Buffering also suppresses the CEM-3328 filter's tendency to oscillate under certain capacitive loads, which can produce birdies at the output, and there is a possibility that outside signals could affect the cutoff frequency of the filter (as the filter output forms one of the filter poles via local feedback).

Because the filters have a very sensitive differential input, it is not uncommon for a filter output to be offset to some DC level other than zero, which could easily cause problems with, or damage to, non-capacitively coupled audio systems. In the Mirage, each filter AC couples into the remaining circuitry to prevent any such DC offsets, but in Don's modification, the outputs are tapped directly off each filter *without* coupling capacitors.

Beyond these reservations, we also feel that the stereo outputs are of limited value. The circuit creates a 4/4 split, where the four voices of each output are assigned to the same place in the stereo field: either hard left or hard right. This does not produce a very natural stereo image and is useful primarily as an effect.

Neither can we recommend modifying the Mirage for eight independent outputs. It is a relatively simple modification, but because the Mirage voice assignment is random, there is no way to control or predict which sound will come out where. Since there is no way to assign a certain sound to a certain output, the independent outputs can't be used to process sounds individually and this is bound to disappoint many users. Finally, we feel that not only will the lack of output muting and volume control in Don's modification be annoying, but (as mentioned in the article) when the filters tune up, they produce full-level sine waves in the 1 to 2 kHz range. This is more than enough to blow out your average tweeter if you forget to turn down your amp when booting up.

If for some reason you prefer to use Don's circuit, we strongly recommend you use the active output summation he talks about towards the end of the article. The summing op amps will provide the desired output drive characteristics and buffering. If you don't add these op amps, you may regret it later if you run into any of the problems mentioned above.

#### AN ALTERNATIVE

The circuit we've developed here is designed to pan each voice to a different spot in the stereo field. This produces a



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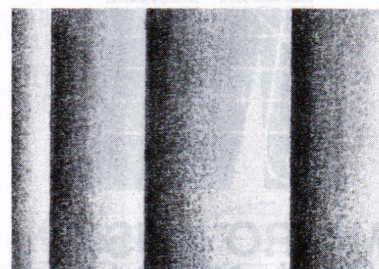
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full stereo field for ensemble sounds such as strings, brass or vocals, and adds animation to percussion sounds by moving them around the stereo field. On some sounds, such as piano, it sounds unnatural to hear different notes coming from different directions, but this can be overcome simply by running the output in mono for these sounds or adjusting the pan pots on your mixer (note also that the ping-pong effect is not as exaggerated as it is in Don's circuit).

As shown in Fig. 1, each filter's audio output is tapped *after* the AC coupling capacitor, thus eliminating any DC offsets. This signal goes to two resistors, one feeding the left audio bus and the other feeding the right. Varying the value of these resistors with respect to each other can position the filter signal anywhere in the stereo field. If the resistor feeding the right bus, for example, is lower in value than the resistor feeding the left bus, more signal will go to the right, making it louder and subjectively positioning the signal further to the right in the stereo field.

The left and right buses feed into a Curtis Electromusic CEM3360 Dual Voltage-Controlled Amplifier. This chip provides two low-noise VCAs with current inputs and current outputs. One VCA sums the left bus resistors and provides the left output, while the other sums the right bus resistors and provides the right output. The current outputs of the VCAs are converted to voltages and buffered by the TL082 op amps. The low-impedance VCA input allows active summation of the signals, which eliminates any signal loss or undesirable interactions that can occur with passive mixing. The op amp outputs are very low impedance, with built-in output protection. The 1 k $\Omega$  series resistor at the output of each op amp provides additional protection in the event of severe output abuse.

### FULLER STEREO

The VCAs provide stereo volume control from the single volume control pot on the front panel. In order to make this work properly, jumper across resistor R20 (3 k $\Omega$ ) and resistor R21 (7.5 k $\Omega$ ). Remove C84 (10 nF or 0.01  $\mu$ F) and C86 (3  $\mu$ F or 3.3  $\mu$ F). Both resistors are located on the far left of the Mirage main board near the ribbon cable connectors. The capacitors are on the far upper right corner, to the right of U48 (NE570). Disconnect pin 1 of U48 (NE570) from the board and con-

nect pin 1 to pin 5 of U48. This modification defeats the muting and volume control at this output and lets you use the original audio output jack as a monitor when sampling.

Since the muting circuit is incorporated into the volume control, the muting function occurs automatically on the new stereo outputs. The outputs will mute whenever the Mirage loads from disk, tunes its filters, or samples. Regarding the outputs, you have two options. Plugging into the left and right outputs gives a full stereo spread; plugging into only the left output picks up a mono mix. This mono mix is available because the switching jack used for the right output routes the right signal over to the left output when nothing is plugged in the right output jack.

The tables given in Fig. 1 list the values for each voice's left and right resistors. These values place each voice at a different spot in the stereo field. The values are chosen carefully to produce equal apparent volume for each voice. Note that two tables are provided for use with different CEM3328 filters. Look carefully at the date code printed on the top of each filter chip to determine which values to use. If your filters have a date code of "8619" or higher, use the first table. If your filters have a date code of "8618" or lower, use the second table (in case you're wondering, "8619" means "the 19th week of 1986"). If you don't use the proper table, the stereo outputs will be distorted or weak.

### WARRANTY VOIDING AND OTHER HAZARDS

Before you tear into your Mirage, remember: once you open the lid, you void your warranty!

Presumably that didn't scare you since you're still reading this and probably opening the lid anyhow. That being the case, please remember this: *there are lethal voltages present in the power supply area of the Mirage. Avoid killing yourself! If you have any doubts about your ability to perform this modification, don't do it.*

Never work inside the Mirage with the power cord plugged in. When checking your work with the Mirage under power, stay away from the power supply and/or cover that area with an insulator (see this month's article on safety in the workplace by Alan Campbell--Ed.).

### HERE'S HOW

When assembling the circuit, we recom-



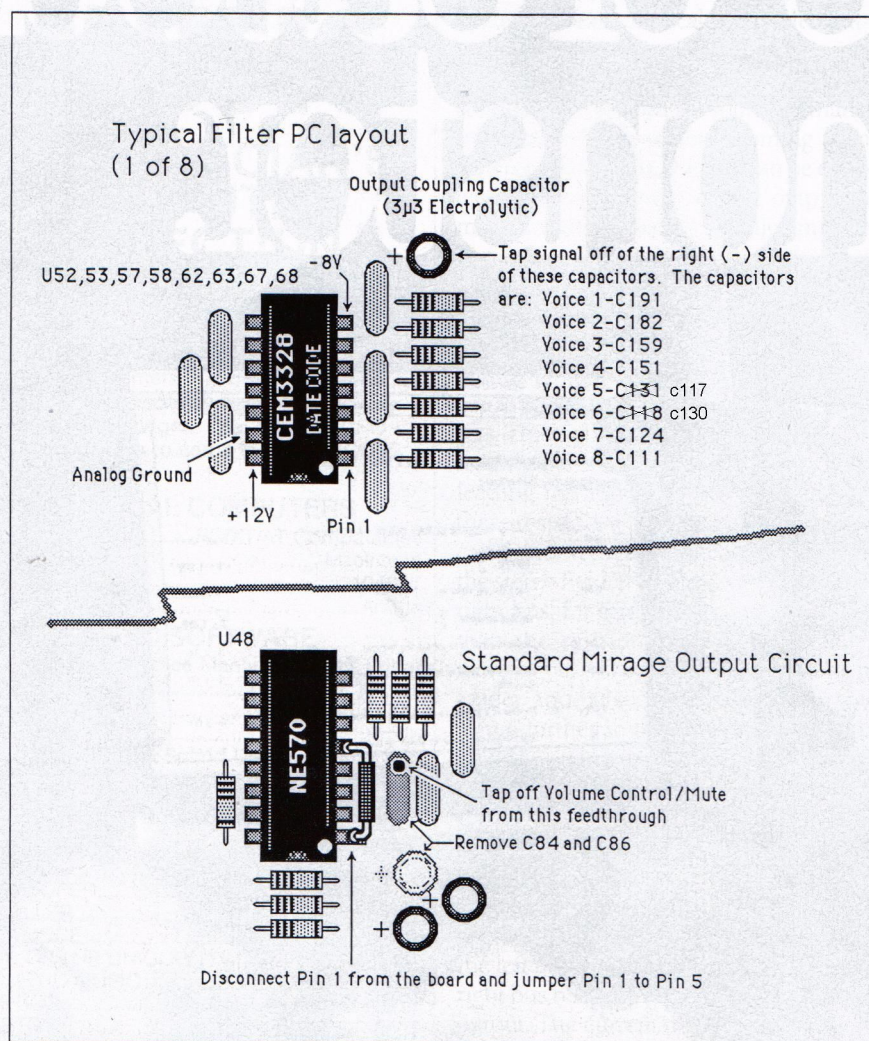


Fig. 2 Mirage Board Layout

mend the use of a printed circuit board if possible. Perf board is acceptable, although you may want to use the copper-clad variety and connect the copper to analog ground to act as a ground plane. This will minimize noise pickup. The output of each filter's coupling capacitor should be picked up at the right ("") side of the capacitor in each filter section; the power supply connections (+12V, -8V, and Analog Ground) can be picked up at any of the filters (see Fig. 2). The volume control voltage can also be picked up as shown in Fig. 2. When installing the output jacks, be sure the jack ground does not connect with the metal case, as this will create a ground loop that could cause hum and noise in the output and sampling input. Concerning parts availability, the CEM3360 VCA is available from Curtis Electromusic Specialties, 110 Highland Ave., Los Gatos, CA 95030 (tel.

408 / 395-3350). The TL082 is available from Radio Shack or almost any electronics parts company.

After assembling the circuit, check your wiring. Using IC sockets for the CEM3360 and TL082 will minimize the chance of damaging these components if there is a wiring error. Use an Ohmmeter to verify that neither the +12 nor -8 Volt power supplies are shorted together or to ground.

### THE BOOT

Turn down the volume on your amplifier, patch the old Mirage output jack into your audio system, and boot the Mirage. Do not turn up your amp until the Mirage is fully running and showing "21" in the display. The Mirage should operate normally (however, the volume slider will have no effect). Verify that all voices are working from the regular output jack.

If everything is working normally, measure the power supply pins of the CEM3360 and TL082 sockets. If the + and - supplies read properly on these pins, power down the Mirage and insert these ICs. Turn down the volume on your amplifier and plug your audio system into the left/mono output jack. Boot the Mirage and set the Mirage volume slider to max. While playing notes, slowly bring up your amplifier volume. If all is working properly, you should hear the normal mono output of the Mirage. Verify that each voice is working and all are approximately the same volume. Next, reduce your amplifier volume, plug a second cord into the right output jack, and plug the other end of this cord into the other channel of your amplifier. Carefully bring up the amplifier volume and play eight different keys slowly and separately. The sound from each key should come from a different spot in the stereo field. Don't hit the same key twice, or restrike a key before it has decayed, as the Mirage voice assignment algorithm will retrigger the same voice. Check that the Mirage volume slider alters the volume of the stereo outputs.

If you are using a mixing board between the Mirage and your amp, plug the left/mono output into one channel and the right output into another channel. Make sure all level, EQ, and phase settings are the same for both channels. Pan the left/mono input fully left and the right input fully right for maximum stereo effect. You can experiment later with the pan controls to constrain the stereo field on different sounds.

To get the full stereo effect, load in Strings or Vocals and play big chords. Stereo outputs greatly enhance the realism of sampled sounds by spreading them convincingly across acoustic space. Hearing a full string section coming from a single spot in space is a dead giveaway that you're hearing a recording (which is, after all, what a sampled sound is). Percussion sounds respond dramatically as different voices jump out at you from different directions. In fact, you'll find that the stereo outputs enhance most of the over 300 sounds in the Ensoniq library as well as the hundreds of Mirage sounds available from other sound designers such as KMuSE. If you've been looking to get more out of your Mirage, we feel this modification is one of the best places to start.

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