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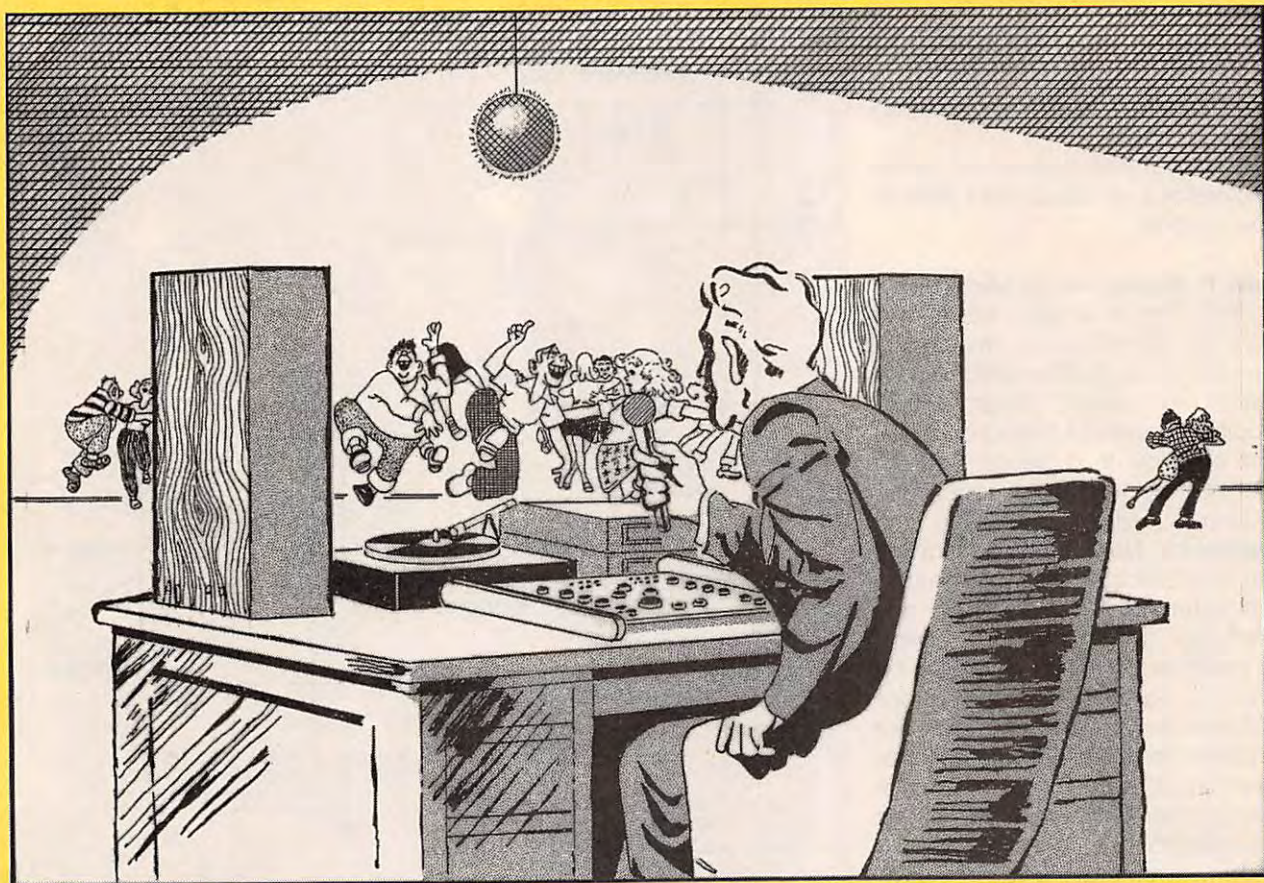
 A GERNSBACK
PUBLICATION



Become the "Life of the Party" with The DJ MixMaster

This portable mixing board is equally at home at a party, in the studio, or anywhere that you need to work with audio.

JULES RYCKEBUSCH



If, like the author, you've done much work with audio in a studio or with live sound, you've probably been asked by friends or clients at one time or another if you could do some "on-site" work at a remote location or if you could "DJ" their next party. The available DJ-mixing equipment on the market of decent quality, unfortunately, tends to be a bit on the expensive side. What's more, much of the reasonably-priced gear for the occasional "record-spinner" uses very cheap components with the resulting questionable audio performance.

Because of that, the only "acceptable" solution this author had found until recently was to lug around his 16-input console—not the most desirable of solutions. Thanks to The DJ MixMaster presented here, those days are over.

The DJ MixMaster is the result of discussions with other DJs, studio engineers, and a personal desire for a mixing console that is a high-quality, low-cost unit with the features that are desired by both professional and amateur "party-fun managers!" It's a compact yet feature-laden small mixing board.

Along with spinning tunes and being the life of the party, there are many uses for such a small DJ mixer. It can be used to put together party tapes that professionally fade from one cut to the next or as a way to practice your karaoke skills. It also sports ideal audio specifications, allowing it to be used as a stand-alone phonograph pre-amp in a recording studio.

The DJ MixMaster provides several features only found on top-of-the-line DJ mixing boards. It features simultaneous access to two phonograph inputs, two line-level

inputs, a microphone input, and an auxiliary stereo line-level input. Most DJ mixers force you to switch between the phonograph and line-level inputs. The DJ MixMaster also features a stereo auxiliary-send output, which can be used to feed the audio to a sampler or a digital-effects processor; we'll look at that feature and its use later in this article. Additionally, there is a full-featured headphone monitoring section that lets you have a separate headphone mix from all of the inputs. Another useful feature is an equalizing section. Although it is a simple tone-control-like shelving EQ with only bass and treble controls, the corner frequencies are set to more musically-useful values than most DJ mixers.

Now that you know what the DJ MixMaster is all about, let's look at how it works.

How It Works. The DJ MixMaster is a collection of simple circuits that form the overall circuit. While each circuit is small, the final circuit would yield a schematic diagram that would be overly cluttered and difficult to follow. In a departure from the normal way that schematic diagrams are presented in **Electronics Now**, each section of the DJ MixMaster will be presented separately. Note that when any particular circuit is either creating or modifying a signal or acting on such a signal, the connections between the circuits of the different sections are represented by a letter inside a circle. While that style of joining different portions of a circuit is familiar to those that have seen it before, a reminder or short explanation never hurts.

At the heart of each of the DJ MixMaster circuits is an NE5532 dual op-amp. The NE5532 has excellent audio specifications and will drive a 10-volt rms signal into a 600-ohm load, giving it the ability to drive headphones with a similar rating directly. Those specifications have made the NE5532 an "unofficial" industry standard for audio use. In fact, most manufacturers of op-amps tend to compare their device to the NE5532 when discussing audio use.

Several pin-compatible op-amps

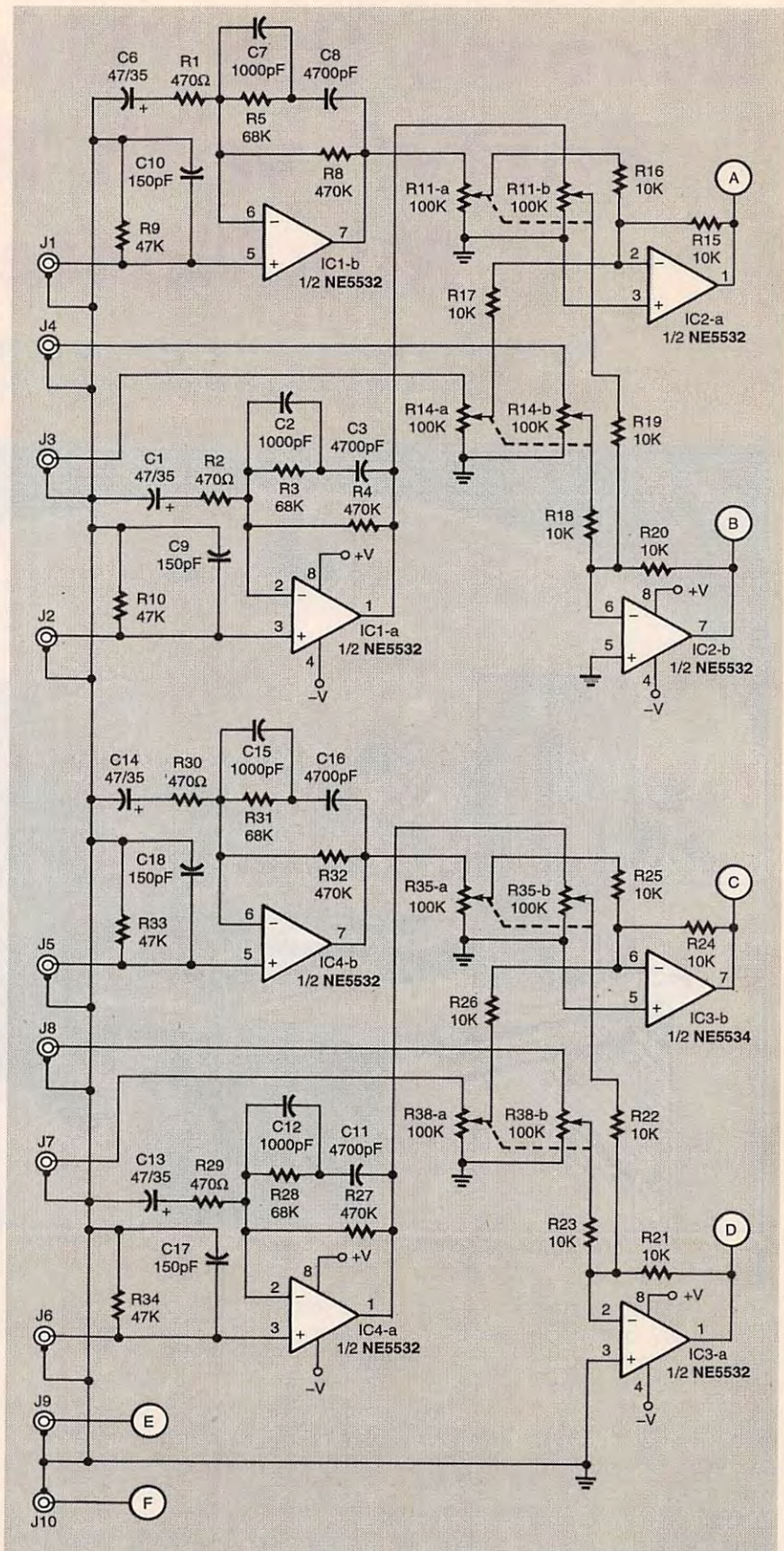


Fig. 1. The DJ MixMaster has stereo inputs for two phonograph turntables and two line-level sources such as CD players or tape decks. Each input level can be set individually. An auxiliary input designed to accept the output of an effects processor can be used as a third line-level input. The phonograph-input preamplifiers are RIAA compensated.

PARTS LIST FOR THE DJ MIXMASTER

SEMICONDUCTORS

IC1-IC10—NE5532 dual op-amp, integrated circuit
 IC11—NJR7815 15-volt regulator, integrated circuit, see text
 IC12—NJR7915 15-volt regulator, integrated circuit, 470-ohm
 LED1—Light-emitting diode, red
 BR1—50-volt, 1-amp, bridge rectifier

RESISTORS

(All resistors are 1/4-watt, 1%, metal-film units unless otherwise noted.)
 R1, R2, R29, R30—470-ohm
 R3, R5, R28, R31—68,000-ohm
 R4, R8, R27, R32—470,000-ohm
 R6, R7, R56-R59, R112, R113—47-ohm
 R9, R10, R33, R34—47,000-ohm
 R11, R14, R35, R38, R49, R51, R53, R61, R63, R88, R91, R92, R116—100,000-ohm potentiometer, panel-mount, audio taper, dual gang
 R12, R13, R36, R37, R50, R52, R54, R62, R64, R66, R89, R109, R110, R115, R117—not used
 R15-R26, R40-R44, R46-R48, R67, R68, R71, R72, R75, R76, R97-R104—10,000-ohm
 R39, R45—100,000-ohm
 R55, R60, R90—10,000-ohm potentiometer, panel-mount, audio taper
 R65—10,000-ohm potentiometer, panel-mount, audio taper, dual gang
 R69, R70, R74, R77-R80, R82-R85, R87—15,000-ohm

R73, R111—22,000-ohm
 R81, R86—75,000-ohm
 R93-R96, R105-R108—1000-ohm
 R114—2200-ohm
 R118, R121—33,000-ohm
 R119, R120—600-ohm

CAPACITORS

C1, C6, C13, C14—47-mF, 35-WVDC, electrolytic
 C2, C7, C12, C15—1000-pF, ceramic-disc
 C3, C8, C11, C16—4700-pF, ceramic-disc
 C4, C5—470-mF, 35-WVDC, electrolytic
 C9, C10, C17, C18—150-pF, ceramic-disc
 C19, C22—1000-pF, ceramic-disc
 C20, C21—0.68mF, Mylar
 C23, C24—47-pF, ceramic-disc
 C25, C26—1200-mF, 35-WVDC, electrolytic
 C27, C28—0.1-mF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

J1-J16—RCA-style phono jack
 J17—Headphone jack, 1/4-inch stereo
 J18—Microphone jack, XLR-style
 S1, S2—Double-pole, double-throw switch
 T1—Wall-mounted transformer, 24-volt AC, 1 amp
 Case, wire, hardware, etc.

one section will be discussed for simplicity. The phonograph inputs from J1 and J2 go to a standard "textbook" RIAA pre-amp built around IC1. One pre-amp is needed for each stereo channel; again, we will only discuss one half of the circuit.

From J1, the input is coupled across R9 and C10 to IC1-b. Those components form a termination load for the phonograph cartridge. The pre-amp is set for a 40-dB gain and is a non-inverting configuration. Two RC networks, C7/R5 and C8/R8, are included in the feedback loop of IC1-b. They reduce the gain of the pre-amp as the frequency increases. The reason that we need to do that has to do with the way that grooves are cut in a record. Higher frequencies are boosted in comparison to low frequencies in a record so that the size of the actual grooves is consistent. The amount of boost is set by the Recording Industry Association of America (RIAA). We are reversing that equalization, restoring a flat-frequency response; hence the use of an RIAA-compensating pre-amp. Additionally, the phonograph pre-amp has a filter network consisting of C6 and R1 that filters out any low-frequency "rumble" from the turntable.

The output of the phonograph pre-amp and the line input are summed into a two-input mixer. The input-mixing stage consists of R11 and R14, both of which are dual potentiometers. The phonograph input level is set by R11; R14 handles the line input. The signals from the potentiometers are combined by a summing amplifier formed by inverting op-amp IC2. The gain of that stage is set by the ratio of the feedback resistors (R15 and R20) and the input resistors (R16-R19). Note that each amplifier receives one channel from each input. The output of the summing amplifiers contains a mixed combination of the phonograph and line-level inputs, of which the level of each can be individually controlled. Additionally, the summing amplifier acts as a buffer amplifier to drive the rest of the circuits, which will be discussed in turn, with no loading effects.

can be substituted, although sometimes it is difficult to actually hear a difference. Examples of some of those devices include the OP-275 from Analog Devices, the LM833 from National Semiconductor, and the OPA2604 and OPA2134 from Burr Brown. Keep in mind that some of those substitutes, like the Burr-Brown devices, can cost as much as \$3.00 each, whereas the NE5532 runs about 60 cents. For those readers with "golden ears", feel free to experiment with alternative devices. Do not use a 741-type of op-amp, such as the LM1458. They simply do not have the ability to function well in high-quality audio circuits.

Input Section. The main-input section shown in Fig. 1 is a good place to start. Note that there are two identical sections, each of which

has a phonograph input and a line-level input for a CD or tape; only

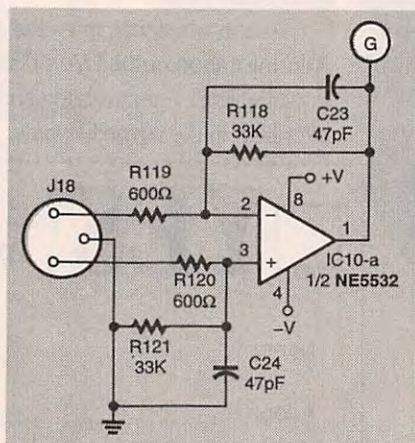


Fig. 2. Any standard low-impedance microphone can be plugged into this preamplifier. The circuit is designed for microphones that have an XLR-type jack. Those microphones use a balanced-line arrangement.

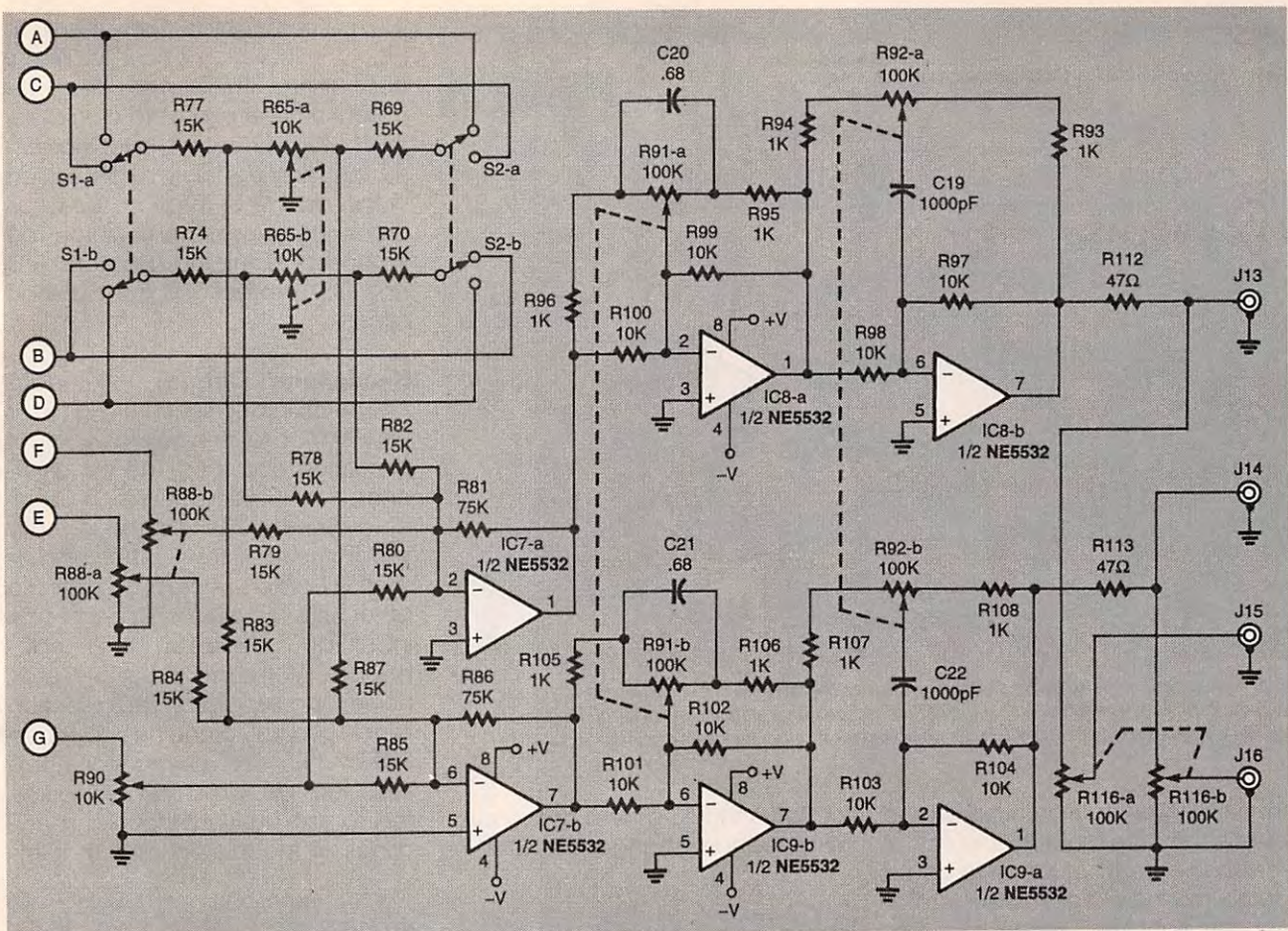


Fig. 3. The "heart and soul" of the DJ MixMaster is the crossfade potentiometer and the transform switches. It is here that the auxiliary input is mixed with the other inputs. The final mixed signal can feed two external amplifiers, or one amplifier and a tape recorder for a "transcript of the proceedings." Bass and treble tone controls are included to help match the sound to the room characteristics and personal preferences.

Microphone Pre-Amp. The microphone pre-amp, shown in Fig. 2, is an op-amp stage that is set up as a differential amplifier around IC10 with a gain of about 35 dB. That amount of gain should be plenty for even the loudest voice. Additional gain is possible as the microphone signal is summed into the other various sections. While such an approach might seem to be a somewhat "cheesy" way to build a microphone pre-amp, the high-quality audio op-amps that are used throughout the DJ MixMaster are up to the task. By using 1% metal-film resistors, noise and circuit complexity are kept to a minimum.

Summing Amp and Output. All of the various inputs are brought together in the summing circuit shown in Fig. 3. The line-level and phonograph inputs are first fed to a

crossfade circuit. That circuit, built around R65, can be thought of as the opposite of a pan or balance control. It allows for a smooth transition from one input to another. Such a circuit is the heart of all DJ-style mixing boards. One of the interesting features incorporated into the DJ MixMaster are "transform" switches S1 and S2. In one set of positions for S1 and S2, R65 is fed with one source input on one side and the other source input on the other side. With that setting, R65 can be used to cross-fade from one input to the other. With the wiper of R65 set to its midrange, each signal is attenuated by about 3 dB. If both signals are identical in amplitude, the output will remain at a constant level as R65 is moved from one input to the other. By throwing one (but not both) of the transform switches, both sides of R65 are fed by the same source sig-

nal. That lets you change instantly between inputs without having to touch the setting of R65. That feature can be useful for special effects and instant changes in the music; no club DJ should be without one! Note that the microphone input (a monophonic signal) is mixed equally into both left and right stereo channels of the summing amplifiers IC7-a and IC7-b; the auxiliary input is mixed in through its own level adjust, R88.

The outputs of IC7 are fed to the EQ section, a standard high/low shelving equalizer very similar to most bass/treble controls. The bass control is built around IC8 and R91, while IC9 and R92 handle the treble. The big difference in the DJ MixMaster circuit is that the boost/cut frequencies are selected to be much more musically useful. The low frequency is centered at about 80 Hz and the high frequency is set

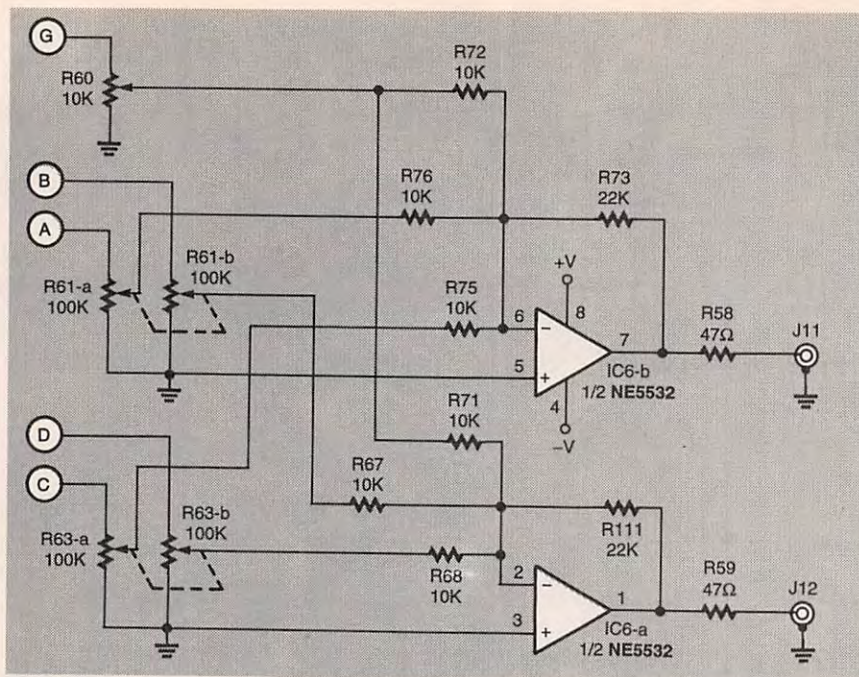


Fig. 4. A separate mix of audio sources—including the microphone—can be sent to the auxiliary output. With an effects processor plugged into the auxiliary outputs, you can add external audio effects and mix them back into the main audio output through the auxiliary input jacks.

for 12 kHz. The available boost and cut range works out to be about ± 14 dB—plenty of range to cause audio mayhem! For more information on equalizer design, two recommended resources are *Audio Application of Operational Amplifiers* by Walt Jung and Don Lancaster's timeless *Active Filter Cookbook*.

The output of the EQ section feeds master level control R116. Output jacks J15 and J16 would be hooked up to an external PA system, while J13 and J14 can be used to record the festivities.

Auxiliary Output. As mentioned before, the DJ MixMaster also has an auxiliary output; the circuit is shown in Fig. 4. The auxiliary output can be used to provide a separate stereo mix for driving another PA system or a tape machine. It can also be used to supply an input to an effects sampler or some other multi-effects processor when the output of such a processor is connected back into the DJ MixMaster through J9 and J10 (see Fig. 1). The two input sections as well as the microphone pre-amp are mixed together with their own potentiometers and summed by IC6.

Note that the choice of values

for R61 and R63 as well as the summing resistors change the "feel" of

the potentiometers from linear to logarithmic, which is how we like to hear things. The further that the potentiometer is rotated clockwise, the faster the output level increases. The most signal increase occurs in the last 1/3 of rotation. The result is a smooth increase in perceived loudness. Coupling resistors R58 and R59 protect IC6 from a short circuit.

Headphone Output. The headphone-amplifier section (Fig. 5) is very similar to the auxiliary output circuit just discussed. The big difference is that the headphone circuit is where the DJ MixMaster really separates itself from other off-the-shelf DJ mixers. Almost all of those other units let you monitor only one input at a time on the headphones. With the DJ MixMaster, however, a separate mixing section is included just for the headphones; R49 and R51 let you monitor inputs one and two, while R53 lets you listen to the auxiliary input and R55 brings up the microphone. That lets

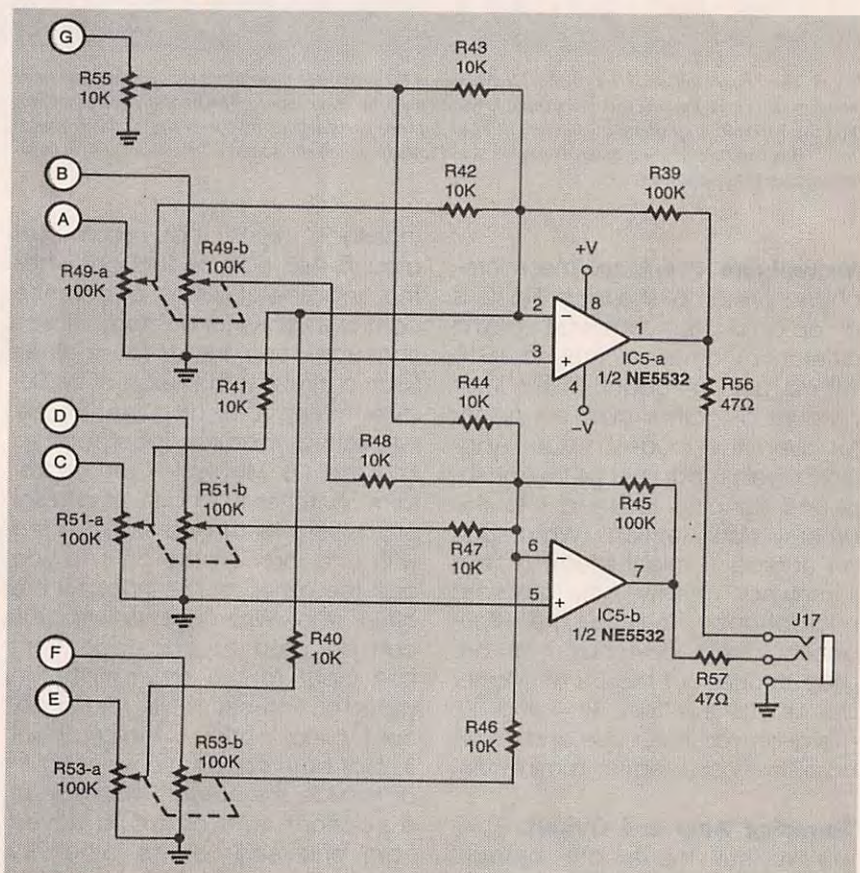


Fig. 5. The headphone amplifier has its own set of mixing controls. With that feature, you can cue up or monitor a different input channel from the one that's playing through the main speakers.

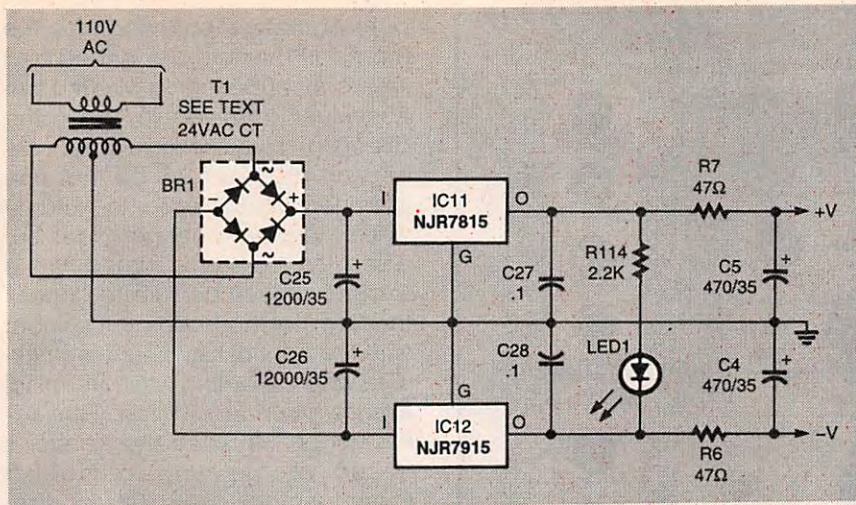


Fig. 6. The DJ MixMaster's power supply uses three-terminal regulators that have an insulated tab; you don't have to worry about using a mica insulator when bolting them to a heatsink.

you match beats, preview an upcoming song, or verify that the microphone is working before sending anything over the PA system.

Like their counterparts in Fig. 4, R56 and R57 protect IC5 from a short circuit; they also provide enough current drive for even 8-ohm headphones.

One final note on the handling of the microphone signal is that only a single-gang potentiometer is used to feed the signal equally to both stereo channels wherever it is sent. Although a stereo-panning potentiometer could have been included, such a function is never really needed in DJ work. For that reason, that feature has been left out of the DJ MixMaster in order to keep the circuit simple.

Power. The power-supply circuit for the DJ MixMaster, shown in Fig. 6, is simple and straightforward. The output of T1, a 24-volt center-tapped transformer, is rectified by BR1 and smoothed by C25 and C26. No fuse is shown because the author's prototype uses a wall-mounted transformer with integral protection. Light-emitting diode LED1 and current-limiting resistor R114 let you know when the unit is turned on.

Note the use of NJR7815 and NJR7915 regulators for IC11 and IC12. While any standard three-terminal regulator can be used, the specified units have the unique feature of an insulated tab. That means that you can mount them straight to a common heatsink

without having to worry about electrically insulating them.

Construction. The DJ MixMaster, in spite of the complexity of the circuit, can easily be built on perf-board using standard construction techniques. One way to lay out the

various circuits for the unit is to build each one on a separate piece of perfboard, one board per schematic figure. All interconnections that carry audio signals should be done with shielded audio cable. Be sure to ground the shield on one end only. If both ends are grounded, the possibility of a "ground loop" exists, the result being stray hum and noise in the audio output.

The case is also a matter of personal choice. The important consideration in that respect is the size of the front panel for all of the controls. The dimensions of the author's prototype case are shown in Fig. 7. The sides and frame are made from poplar wood (for looks) with 1/8-inch sheet aluminum for the front and rear panels. The front panel measures about 10 inches by 16 inches.

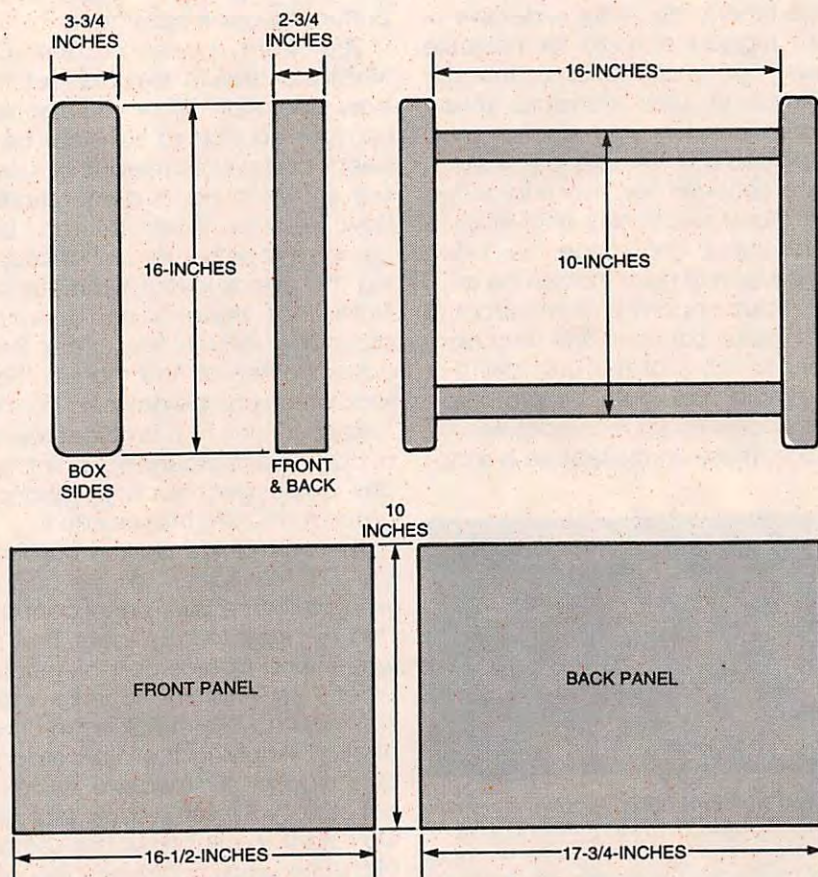


Fig. 7. While any suitable enclosure can be used for the DJ MixMaster, the author's design is large enough to allow an easy-to-use front-panel layout. The unit can even comfortably fit in one's lap.

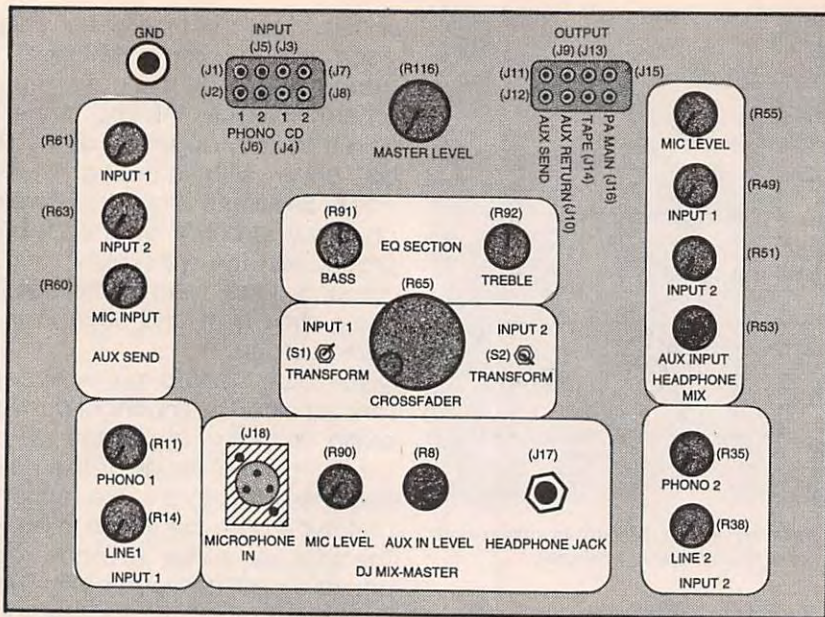


Fig. 8. A clean and orderly layout of controls is essential to any well-designed mixer. Here's how the author organized his prototype DJ Mixer. Feel free to modify this arrangement to your liking.

Along with being the right thickness, street signs are T-6066-grade aluminum. Old dented ones can usually be had for free.

Many mixers use slide pots. Unfortunately, those types of controls tend to be either expensive or not rugged enough for portable use. For that reason, the DJ MixMaster uses standard rotary potentiometers. Any control knob that feels comfortable to you is fine. One consideration that is forgotten by many electronics enthusiasts is that of style and image. The "look" of a piece of gear that will be used at a club or party is as important (if not more so) than the technical specifications of the unit itself! For example, the author's prototype uses collet knobs manufactured by Selco. Those knobs feature a snap-

in face that comes in many colors. Unfortunately, they are more expensive than the potentiometers that they control! For R65, you might consider an extra large knob with a handle. Being able to "crank" R65 is perfect for quick crossfades.

The front panel of the DJ MixMaster should be laid out for easy operation. While you can set up your controls to suit your own needs and desires, the author's layout, shown in Fig. 8, demonstrates how related controls can be grouped together as well as keeping the overall layout symmetrical. Note that there is an optional grounding jack in the upper left-hand corner of the panel. That jack, which can be anything from a "banana" jack to a simple screw, is a convenient grounding point for any audio gear such as phonograph turntables that require it.

The bulk of the work in building the DJ MixMaster will be spent wiring all of the front-panel controls and the input/output jacks. That is why mixing boards cost so much! What's important is to take your time and double check each connection. Applying the old carpenter's adage of "measure twice—cut once" will result in a unit that will work right the first time. The use of plastic tie wraps or cable lacing will aid in a neat and tidy job.

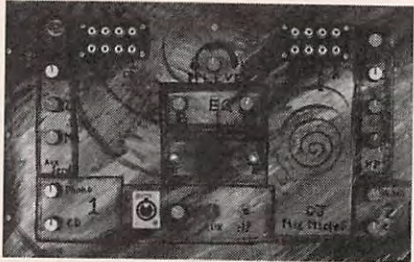
When wiring the dual-gang

potentiometers, note that for the most part they are being used as a level control. Be sure to wire the two non-wiper terminals in the same direction. If you reverse one connection, the result will be that one channel will increase in volume while the other channel fades out when the control is turned. On a related subject, be sure to choose the terminal that shorts to the wiper with the control fully counter-clockwise when selecting which terminal is to be grounded. That way, the signal will be off when the control is turned all the way to the left (counter-clockwise). Of course, there's nothing wrong with wiring the DJ MixMaster so that it works opposite to the traditional arrangement that we are all used to when working with a rotary control. In fact, a DJ Mixmaster that reads "right to left" might be just the thing for those that like to march to the beat of a different drummer!

If you do not want to use a wall-mounted transformer, a standard transformer with a current rating between 300 mA and 1 amp can be used. However, you will have to include additional safety equipment such as a fuse and a power switch. The 110-volt wiring inside the DJ Mixmaster can not only be a problem as a source of hum pickup, it can be very dangerous working around while repairing, modifying, or testing the unit. For those reasons, a wall-mounted transformer cannot be recommended enough from a safety standpoint. On the subject of safety, don't forget to ground any metal panels on the case; a good ground will be needed with some audio gear such as phonograph turntables mentioned before.

Once the DJ MixMaster is built, wired, and checked for any errors, it is ready for testing.

Testing. Because there are so many interrelated sections of the DJ MixMaster, testing must be done in a logical fashion to ensure that everything works properly. Let's start with the headphone section and the auxiliary-return input. Since that combination is a straight-through connection, once we know it works we can check out the other inputs



The DJ MixMaster can be decorated in any way that you choose. The front panel of the author's prototype was painted by a friend that decorates and custom-paints surfboards—an example of taking the concept of "style and image" to an extreme!

using the headphone amplifier.

Set all of the controls to their minimum value. Connect a stereo line-level source such as a CD player to J9 and J10. Plug a set of headphones into J17. Start the CD player and turn up R53. You should hear clean, crisp audio with no distortion. Turn down R53 and turn up the other controls. You shouldn't hear any hiss or hum. Connect a microphone to J18 and turn up R55. When you speak into the microphone, you should hear yourself talking along with any other room noise. Go through all of the other inputs (J1-J8) in turn, checking them in the same way. Don't forget to ground any phonograph turntables or the result will be a horrible-sounding test!

Once you have verified that all of the inputs work through the headphone amplifier, connect J15 and J16 to an amplifier and speakers; your stereo will work fine. Repeat all of the different tests, verifying that you can send them to the main mix. Set S1 and S2 in various combinations to see if you can switch between inputs as well as crossfade from one to the other with R65. Any problems that turn up are most likely caused by an error in wiring or a possible solder bridge on one of the perboards. Remember, even the most careful person can make a seemingly obvious mistake, especially with a circuit as involved as the DJ MixMaster. Once you have checked everything out successfully, it is time to see what cool things the DJ MixMaster can do.

Using the DJ MixMaster. Using the DJ MixMaster is straightforward. Start by setting the input channel levels. Connect your turntables and CD players. Bring up some music on both the phonograph and CD player for the same channel—for example, J1-J4. Set S1 and S2 so that only that input is connected to R65. Adjust R11 and R14 for equal volume levels. Note that those controls should not be fully raised but somewhere in the one- to two-o'clock position. Phonograph signals are a little louder than the line signals, so R11 might be set a little lower. Repeat that procedure for

the other input. Once both input levels are set, they will stay there; your mixing will be done with R65. However, you have the flexibility to do additional submixing. One interesting trick is to leave a turntable running with the needle at the end of a record. All that you will hear is the repetitive scratching sound of the record. Mix that in with music from CDs as an effect. That is easy to do with the DJ MixMaster because you can have two CD players and a turntable connected at the same time. Most other mixers force you to switch between the phonograph and line-level inputs.

Transform switches S1 and S2 take a little getting used to. They let you instantly switch between input channels. With a little practice, you'll be the hit of the dance floor. You can do things like create an "extended mix" of a song by having two copies of the song playing. At the end of one chorus or break, cue up the second copy at an earlier portion and hit the transform buttons. That is also how DJs bring in scratching from a turntable or other sound effects.

The auxiliary input and output circuits let you do all sorts of audio mayhem. For example, digital multi-effects processors for use in studios are available for less than \$200. Almost any effect that you have heard on a song or the radio such as reverb, delays, flanging, chorusing, and pitch transposition are all available. Some will even "sample" the input applied to them; they will digitally record the audio fed to them for about five seconds and store it, ready to be played back at the push of a button. When used with the DJ MixMaster, you can process your voice when making announcements, process the music you are playing, and sample either your or someone else's voice. In a club, you will be right up with the best DJs. For example, you could use a pitch-transposing device to drop your voice down by a fifth and say something like, "You! In the red dress! You are evil and no one on this planet likes you!" At functions like weddings where some one is making a toast, sliding a little delay on their voice unexpectedly can result in all sorts of fun. Don't go

overboard with an effect like that, but it is the perfect thing for a slightly-tipsy relative who is trying to make the "speech of the decade". The possibilities are endless. If you won't be using effects processors, the auxiliary input can be used as an additional CD player or tape deck.

The DJ Mix Master is a formidable audio tool. It is compact, yet has features not found on even top-of-the-line mixing boards. You can easily build it in a couple of evenings and then launch yourself into a new career as a Disc Jockey or at least have a lot of fun at parties! Ω

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