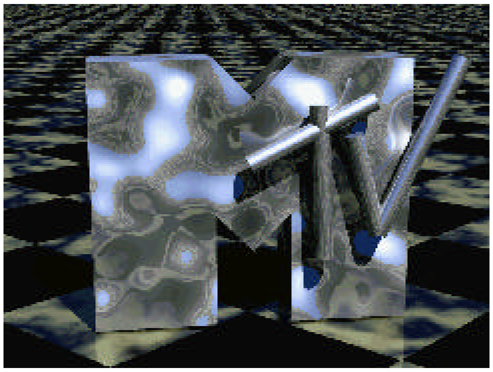
Who needs



when you've got the CD BUDDY!?!

The CD BUDDY project

Design Project Team Members

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INTRODUCTION

In many Asian countries, the karaoke player has become a favorite pasttime. Not only is the karaoke player present in the majority of bars and night clubs, but its presence has also been increasing rapidly in residential homes. In Japan, the karaoke player has even emerged in taxi cabs. Although its presence is not yet as dominant as in Asia, the popularity of the karaoke machine has grown steadily here in the US. Due to its increasing popularity, we believe that there exists a profitable market for a karaoke player that is more mobile and compact. Thus, for our design project, we will build a more mobile and portable version of the karaoke player. We will call our device, "the CD Buddy."

OBJECTIVE

Our goal for the CD Buddy is to design, layout, and construct a prototype unit with the inclusion of special added features such as reverb. The design and layout portions will contain the actual schematic of the production unit, document the internal case layout, and include a functional circuit diagram. A prototype of the CD Buddy will be breadboarded and tested. Finally, the functional circuitry from the breadboard will be transferred to a circuit board, soldered, and put in a case will all the necessary control functions.

FEATURES

In addition to being compact and mobile, our portable karaoke player will include user friendly enhancements and other conveniences as listed below.

- Operation from two 1.5V AA batteries
- AC adapter power supply input
- Car cigarette lighter - power interface
- Stereo RCA inputs for use with home stereos
- 1/8" headphone inputs for use with Discmans or Walkmans
- Microphone input jack
- Convenient engage/disengage switch
- Walkman/Discman velcro strap attachment
- Low power consumption
- Low noise pickup design
- Extended bass and treble response

CONCEPTUAL OVERVIEW

Conceptually the CD Buddy works based on the concept that most stereo recordings have the main vocal equally recorded on both channels (L+R) and all other instruments are recorded to one side of the center channel. From the producer's point of view, this is done so that the listener perceives the main vocals coming from the center of the two loudspeakers. By having the other instruments off the center channel, the listener hears a wide stage. In other words, the listener would perceive a live band directly in front with the vocalist at the center and all other instruments to the left or right.

This recording technique is important with respect to the CD Buddy because it allows us to filter out the center signals (the vocals) and pass all other frequencies (the instruments). This is acheived by subtracting one signal (right or left) from the other. We call this arrangement "L-R" or "R-L." One problem with this scheme, however, is that the bass guitar is also generally recorded equally on both the left and right channels, for several reasons. One reason is that when we hear bass, the direction at which the tones are coming from cannot be determined exactly. Thus stereo imaging is superfluous at low frequencies, so recording engineers tend to simply record it in "mono," which is yet another way of saying that the signal is the same in both channels. This is why subwoofers are only one unit. Secondly, there might be phase cancellations in the playback system or mono-radio transmission. The point here is that since the CD Buddy subtracts the left and right signals to remove the vocals, portions of the bass tend to be removed as well.

SYSTEM IMPLEMENTATION

As mentioned in the conceptual overview, some mid-bass loss will occur when taking out the vocals. To solve this problem, we used filters to remedy the bass cancellation. We added a low-pass filter (below 160 Hz) that bypassed the subtraction circuitry. Then, we added high-pass filters (above 160 Hz) in between the inputs and the subtractions circuitry. This meant than essentially, any signal below 160 Hz would be diverted directly to the ouputs, while the portion above 160 Hz would be subtracted L-R. Active filters were used to avoid bulky and costly inductors and prevent signal loss. We used filters with a -20dB per decade configuration. We determined the resistors and capacitors needed to complete the filters (both low & high pass), with the following equation: 2*pi*Fc = 1/(R*C). To determine our crossover frequency (Fc), we hooked up a function generator and found the lowest frequency which we could match with our voices. This frequency would be the cut off point to pass low frequencies and pass high frequencies. The determined cut off frequency was 160Hz.

Having resolved the bass problem, circuit parameters and component values, the CD Buddy basically works as follows:

First, the input signal(s) are sent to a double throw switch which will determine whether the karaoke function is engaged or not.

From the switch, the signal goes on to both the low (U3A) and high pass filters (U1A & U2A). The low pass filter passes only the low frequencies (the bass) and nothing else while the high pass filters passed the high frequencies (instruments and vocals at this point) for both the left and right channels separately.

Output from the high pass filters (containing both instruments and vocals) are then passed to another op-amp (U9A) set for unity gain. Op-amp (U9A) subtracts the left and right signals and passes the resulting signal (consisting of instruments only) to (U10A) where it is combined with the low pass and microphone filter outputs.

The op-amp filter (U4A), along with the adjustable potentiometer (R9) was used to set the desired gain of the microphone input level.

Figure 1 shows a functional circuit diagram of the CD Buddy and corresponding op-amp (UXA) designations.

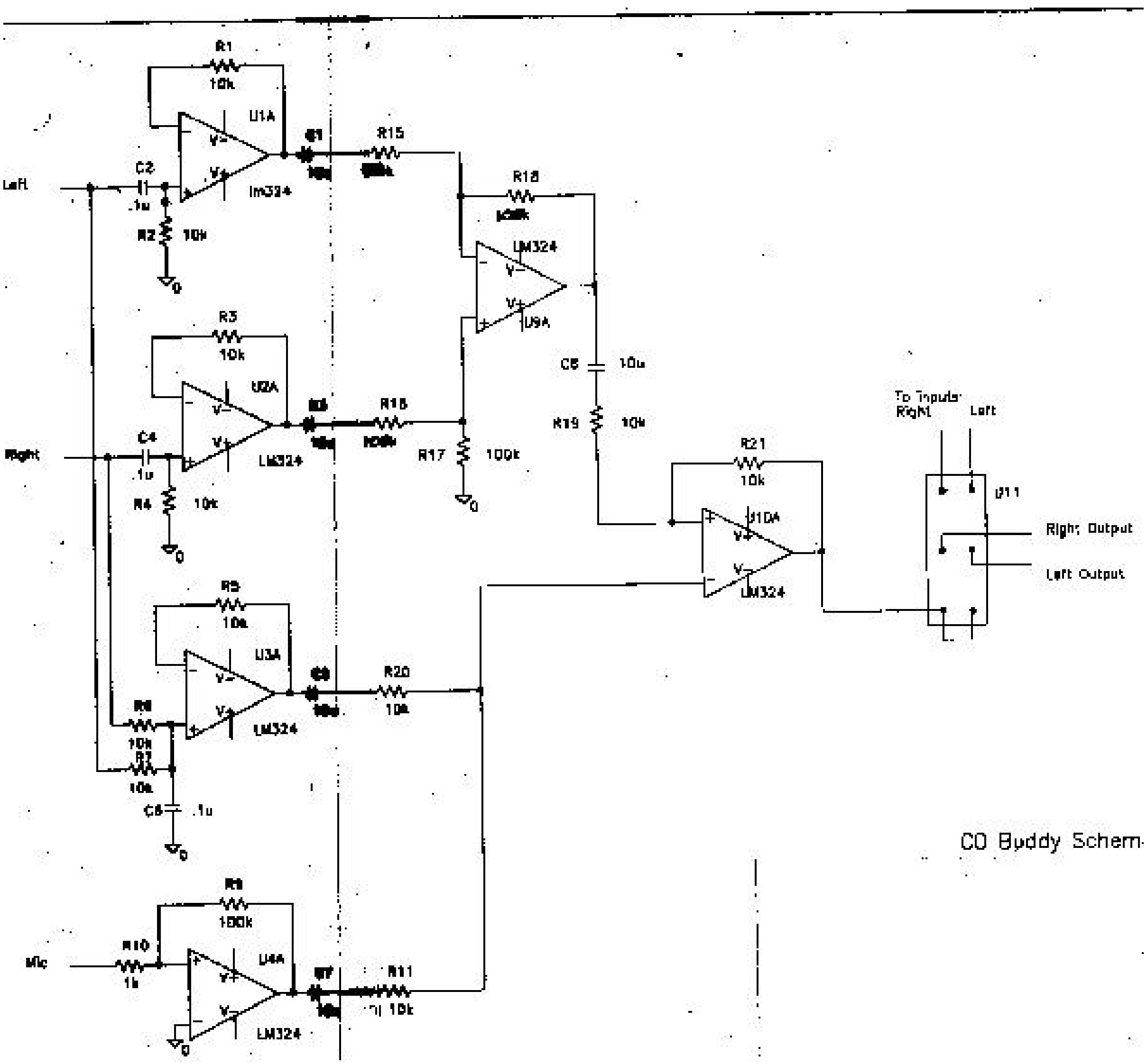

Figure 1. Functional CD Buddy Circuit Diagram

LAYOUT AND ARCHITECTURE

The CD Buddy was designed with compactness and portability in mind. Via a velcro strap, the CD Buddy can be attached to most Discmans and Walkmans. Refer to Figure 2 , for attachment and dimensional aspects of the CD Buddy.

Figure 3, shows the internal layout of the printed circuit board (PCB) along with the accompanying chip sets and input jacks.

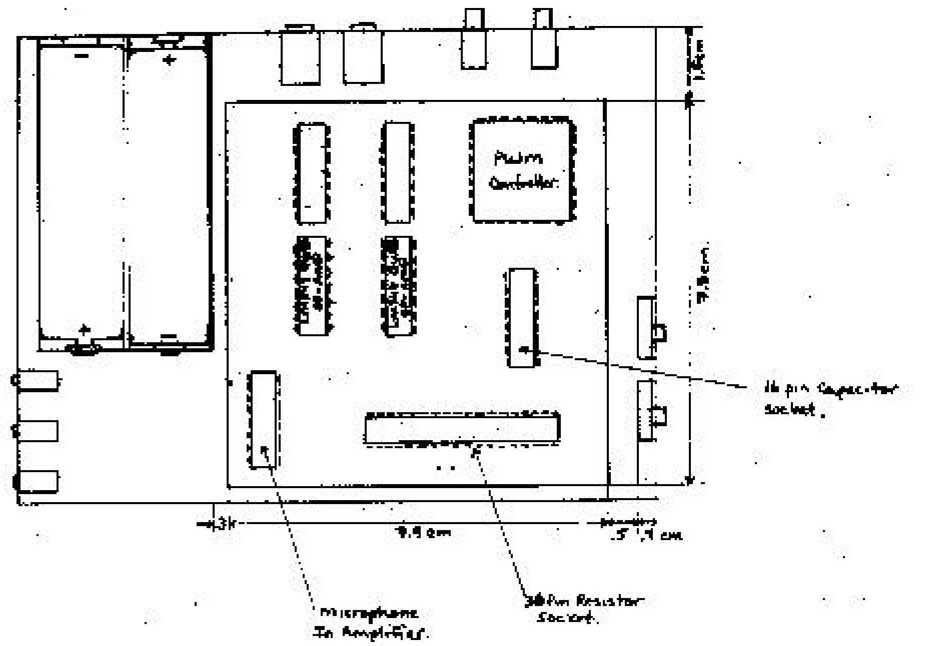

Figure 3. CD Buddy internal chip and PCB layout

The architectural design of the CD Buddy, at this point, consists of using discrete components and a layered PCB. The layered PCB is simply a PCB comprised of several layers of compressed copper of several microns thickness. Layered technology allows the ability to have traces run under other traces without electrical contact. Thus, using a layered PCB is important because it allows greater complexity in the circuit design within a small amount of space.

Although the CD Buddy is operated off two 1.5V AA batteries, some components require higher operating voltages. To step up the input voltage, an inductor along with a pulse width modulator (PWM) will be used. Due to space considerations, the inductor will be of the newer planar magnetics technology. With planar magnetics, the actual windings of the inductor are printed on a circuit board and spiral down through one side of the PCB, using the layering technology, and comes out the other side. Two magnetic cores are then "slapped" on both ends of the PCB. As a result, much space is saved and the varying inductance of a hand/machine wound inductor is reduced.

TECHNICAL RESULTS

Actual testing of the CD Buddy was done with the cased and wire-wrapped prototype. The following data was acquired.

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Dimensions   :      13.2(W) x 9.6(L) x 1.6(D) cm

Current draw :      5 mA per side (L/R)
                    10 mA total

Power Consump:      50 mW approx.


Data for the determining of the frequency response

Frequency           Voltage (mv)   Voltage (mV)
     (Hz)           w/1 channel    w/2 channels

     100            128            129
     250            130            102
     500            137            75
    1000            142            44
    2000            143            23
    4000            143.9          12.5
    8000            144.2          7.2
   10000            145.8          6.5
   15000            143.8          5.6
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DISCUSSION OF RESULTS

With power and current consumptions in the mW and mA range, the CD Buddy should run pretty cool and as a result, both chip and battery life should be prolonged.

The frequency response for the circuit was determined by first converting the voltage level to decibels with the following formula: dB = 20 * log (V) where V is the voltage reading. Then, both the frequency and the dB (gain) were plotted. The result of both frequency response plot were as expected. On the plot (Fig. 4), for the single channel injection, a flat response resulted.

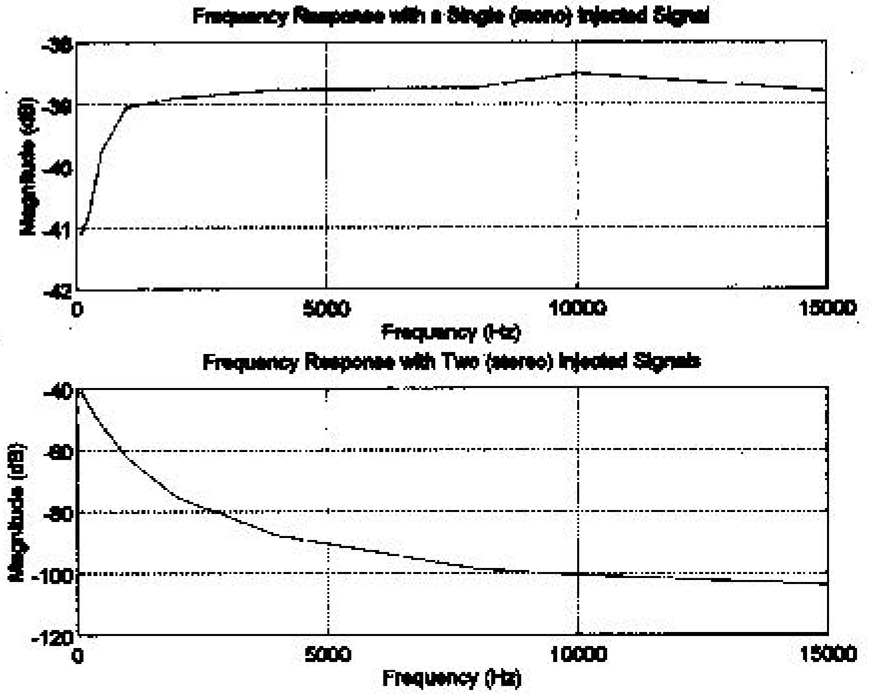

Figure 4. Freq. response for a single & double signal injection

This was expected because the subtracting op-amp (U9A) had only one signal to "subtract"; consequently, without both the left and right signal, the op-amp passed both the low and high frequency signals. For the injection comprising of both a left and right signal (Fig. 4), a plot resembling a lowpass filter resulted. This was because with a left and right signal, the "subtracting" op-amp gave a near zero output, so the "mixing" op-amp had only the bass signal to output. The bass signal is the lowpass frequency response.

LIMITATIONS & IMPROVEMENTS

Although many features and conveniences were packed into the CD Buddy, some limitations still exist. Due to its compactness, the CD Buddy lacks the video playback feature that only a full blown karaoke player can provide. Thus, users will have to know the song and its pacing to sing along. Newer technology may permit the combination of video and audio on an audio CD. If so, the CD Buddy can be revised to incorporate a small LCD screen showing the song lyrics. At this point, however, due to our compact design, and the fact that the existing circuitry occupies most of the case, it seems unlikely that video playback circuitry could be added.

Lastly, a conceptual "shower buddy" may be in the working as a future product. The shower buddy would be a waterproof version of the CD Buddy, allowing the enjoyment of karaoke in the shower.

PRICING AND PRODUCTION COSTS

The following is a parts list of the cased prototype CD Buddy. Pricing on this list reflects the prices charged by a retailer. Actual production component prices will be cheaper as they are bought in greater quantities and from wholesalers

Part #	Description	Cost($)	Quant.	Total
n/a	1Kohm, 1% Resistor	.11	1	.11
n/a	10Kohm, 1% Resistor	.11	11	1.21
n/a	100Kohm, 1% Resistor	.11	5	.55
n/a	0.1uF, 5% Capacitor	.22	3	.66
n/a	10uF, 5% Capacitor	.22	5	1.10
LM348	Quad. Op-amps	.98	2	1.96
	Push button switch	1.29	1	1.29
	Double pole switch	.99	1	.99
	1/8" Microphone jacks	.49	1	.49
	RCA Jacks	1.99	4	1.99

The actual production CD Buddy unit will contain these additional parts. Price estimates are based on prices for similar consumer products. (These estimates should be high, as actual manufacturing costs tend to be significantly lower than retail price)

Part #	Description	Estimate Cost($)	Quant.	Total
	PWM Controller	?	1	- - -
	Plastic Casing	2.00	1	
	Battery Terminal Sockets	.50	2	
	Car Cigarette Lighter Adpt.	5.00	1	
	AC Outlet Adpt.	5.00	1	

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Total cased prototype unit cost      :  $ 10.35
Total of additional prod. unit costs :  $ 12.50+PWM
Total cost of production unit        :  $ Sum of above 2 costs
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In addition to the total production unit cost above, we estimated that manufacturing and labor cost would approximately add another 15%-25% per production unit. This estimate is based upon a rough estimate of the manufacturing costs of similarly priced electronics. Essentially, we estimated the price of the actual components in a device, then we subtracted that from one fourth the retail price. (We've been told in class that consumer electronics products are generally made for a fourth of their list price.) This is simply to give us a very rough estimate.

ENDING STATEMENTS

Though the introduction of the CD Buddy will be a relatively new product in the U.S. market, we believe that its popularity will eventually catch on - as in the Asian market. Due to its compact and material efficient design, the cost of CD Buddy will be relatively cheap compared to its full featured laser karaoke "brother," without sacrificing many features. All in all, we believe that the CD Buddy is a product that is worth developing and investing in.

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