DEVICE The Publication for Electronic Musicians

VOLUME ONE:TWELVE:SEVENTY-NINE/ONE DOLLAR&FIFTY CENTS

BY THOMAS HENRY PART ONE

STALKING the SAD-1024

In which Tom takes us through the paces and traces of the popular Reticon BBD chip

This article is a compendium of tips and hints on using the SAD-1024 analog delay chip. In it, I won't concentrate on the theory of the chip, but rather on the practical aspects of getting the chip working in most circuit configurations. There has been a fair amount of literature published on the chip, and in some cases there have been contradictory statements made about the chip's wants and needs. I hope, then, to clear up some of the confusion and also to review some things that you possibly already know.

At the end of the article I have listed my sources. The material has been numbered, and noted in the article by those numbers. For more information on a particular topic refer to the numbered reference. In most cases the original article will give you the theory and design notes and other ideas that can give you further depth on this subject.

I should say a few things about the sources. You can probably find the *Radio-Electronics* and *Popular Electronics* in your local library. However, the other sources aren't quite so easy to locate. I have given some addresses to help you along though. *Polyphony*, *Electronotes* and *Technotes* are, to my knowledge, all available on a back issue basis. Write to the respective publishers for pricing information. The Reticon information is available to "qualified" persons only. Qualified, in this case, means you must be in a business, school, or so on, and write for the literature on "official" stationery.

Finally, I've listed Marvin Jones' *String Synthesizer* article because it illustrates how the SAD-1024 can be incorporated as an integral unit of and instrument, and further demonstrates the concept of chorusing.

INPUT CONSIDERATIONS

1. The input signal to the SAD-1024 must be appropriately conditioned to avoid distortion. First, the input level *must* be below 2V peak-to-peak. If the signal is lower still, say below 1.4V p-p, the manufacturer claims less than 1% distortion. However, there is some chip-to-chip variation, an a particular chip may be able to handle 1V p-p max. Play it safe then, and limit the input level to 500mV p-p. Between the 500mV and 1V p-p level the peak (not average) signal to noise ratio (S/N) is greater than 70dB. *(See note 8.)*

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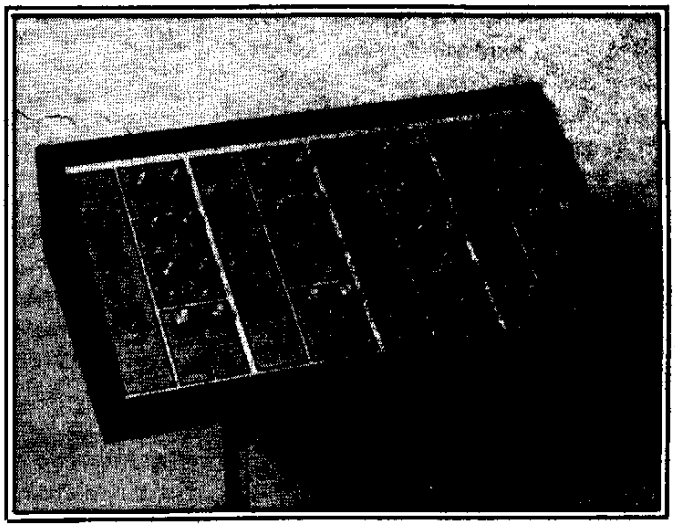
review

DRUMMERS STRIKE BACK!

BY RON MINEMIER

The PAIA DRUM kit is put through a shake-down cruise

Synthesizers have grown; many people still think of synthesizers as keyboard instruments although now some operate under digital control with programmable presets and/or polyphonic voicings. However, the synthesizer's growth has gone far beyond just voicing sophistication, since new interfacing electronics allow non-keyboard musicians synthesizer expression. While pitch to voltage converters have garnered a lot of attention since they allow guitarists and other acoustic musicians full synthesizer control, there are a growing number of special purpose interfaces. With this review we will explore some of the capabilities of the percussion/synthesizer interface by examining PAIA Electronics' new kit **The Drum.**



Intended to be a modular block, each Drum kit ($59.95 postage paid) has one complete drum voice. A four channel system with case and power supply sells for $269.75 and assembled units are available.

Many **DEVICE** readers are familiar with PAIA, as it is one of the larger musical electronics firms in the U.S. geared specifically to kit builders. For anyone just starting in electronics, it's difficult for me to think of a better place to start

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notes from napa

"Jeez! Will these guys ever get an issue out on time!"

This is a good question and seeing as I am publisher of this "monthly" I'm the one who must come up with the answer.

The answer is most definitely **Yes!** *Recent history has not exactly born this out and this is a part of our operation that must be straightened out.*

With a publication like **DEVICE,** *that fills a very special niche, absence from regularity is quickly noticed by the readership....you are anxious to get the new and hard-to-find information* **DEVICE** *is noted for. So when you don't see an issue on time (and I know what that's like) you begin to wonder, "Are these guys still around or what?" Everyone is getting* **and will continue to get** *the issues they have paid for. We have a deep-seeded commitment to giving you your moneysworth and although it has taken us a year and a half to get there — twelve issues we have delivered!*

This has not been an easy accomplishment and we have tried to keep you informed when we have had set backs. Our recent lag in publishing is due to another problem—the publisher.

Not too long ago, Craig (this time) moved and put enough miles between us so that the majority of the layout and production fell on my shoulders again. The appearance of **DEVICE** *is a great source of pride for me, but (even though I've been doing this for 1½ years) there are still a great many things I have needed to learn — and I have, at times, allowed this learning to disrupt the flow. Our current delay revolves around my learning more about magazine production discipline. I realize that this takes a certain amount of planning and habit building and I am on a campaign to institute this. Understand, that the time Craig or I can devote, at present, is only partial. But don't for a moment think that we are not commited! This is neither Craigs or my full time job — but it one of our passion.*

The intent here is that Craig and I, with your involvement, will continue to make **DEVICE** *grow. The gathering of the necessary ingredients to cultivate this idea has been part of my problem of not meeting publication deadlines. For this, I apologize; but, I think, In the near future, you will understand. I think you will also be pleased!*

* * * * * *

With this issue many of you will have reached the end of your subscription. We have included a combination **DEVICE-A-GRAM** *and subscription form. Fill out both. Without your input and support there is no network. Besides you're* **really** *going to get your money's worth with the next volume of* **DEVICE.** *—Roger*

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DRUMMERS STRIKE BACK

(continued from front page)

than with a PAIA kit. Although many of their kits are modules meant to form a complete keyboard synthesizer, the Drum can be used as a stand-alone effect. The instruction booklet reflects this as it is much larger in terms of size (bigger print, too) than many of their other instruction manuals. There is a special section on proper soldering technique along with plenty of photographs and illustration so even a raw beginner will have no problems, providing he or she can read and follow directions carefully. The P.C. board is legended to aid in correct, speedy board loading. As with their other kits, there are full schematics, parts placement drawing, and design analysis sections. Unlike some of their other manuals, the Drum's schematic can be lifted out separately so that you may read through the design section while tracing the schematic instead of constantly flipping pages back and forth — a nice touch.

Before getting into the actual circuit, a word on packaging. In the Drum *all* controls are soldered right on the P.C. board. This eliminates a great deal of point-to-point wiring. A pleasantly colored and stenciled faceplate then fits over the pot shafts, switch and status LEDs. Total assembled dimensions are a slim 9" long by 4" wide and 2" deep. The faceplate is held on by the nuts on the pots, and is fabricated from a piece of heavy duty 1/8" aluminum. There are six patching jacks (all standard ¼" phone types) that mount on a small prepunched plate for installation in the four module system case. The jacks can, of course, be mounted differently depending on your application.

The Drum is made up of five functional blocks: an interface section to derive trigger pulses and control voltages, a voltage controlled oscillator, a white noise source, a voltage controlled bandpass filter, and a voltage controlled amplifier.

The interface section is driven by a piezo-electric transducer. This sensor (it looks like a hockey puck painted robin's egg blue) has the ability to produce an output voltage that is proportional to the mechanical force applied to it. In speaker systems piezo tweeters use this same property (only in reverse) to convert electrical signals to mechanical motion. The sensor can be mounted in or on an existing acoustic drum, or in a strike pad of one's own design. The instruction manual covers various options and

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many other applications are possible for custom percussion installations.

The sensor connects to the electronics through a piece of coaxial cable terminated in a ¼" phone plug. A pot taps off this signal and sets the triggering sensitivity to taste.

The voltage from the sensor drives a combination envelope follower/ Attack-Release generator. This stage provides a fixed fast attack, variable decay envelope to control to the VCO pitch, filter sweep and VCA. The other half of this circuit produces a short duration pulse and a stretched version of the pulse to drive an LED indicator. [*Editor's note: a "stretched" pulse is necessary in order for you to see the flash from the LED. If the pulse was not stretched the the LED indicator would flicker too quickly for the eye to perceive it. Therefore, the width of the pulse needs to be widened so that the LED will remain on long enough for it to register with our eyes. For more on the subject refer back to the AMS-100 rhythm generator in DEVICE 1:10.*] Both the trigger pulse and envelope control signal are available at an output jack, and can be used to drive other voltage controlled elements. The envelope rises to about +8V max and the pulse to roughly 9V. Because the sensor is coupled to the electronics through a ¼"jack it is an easy matter to trigger the Drum from various sources such as microphones, and A/R generators, computer outputs or whatever. This interface section also has a jack for an SPST footswitch. The footswitch performs a cancelling function to disable the interface section (thus producing no output) and is convenient when the Drum is being used in conjunction with an existing acoustic drum set.

Now that we have the brain of the system (timing and control) we'll look at the heart of the "beast" – the VCO. Built around a 566 VCO IC, two waveforms (triangle and square) can be mixed together in any proportion by a single, pan pot-like control; the combined waveform goes to another mix pot where filtered white noise can be mixed in on the way to the VCA. The 566 is a fine choice for a percussion synthesizer VCO since we do not need a high spec tracking or temperature compensated device. An intial pitch control sets the starting frequency. Upon receiving a trigger, the control envelope arrives through a modulation control and one of three things will happen. With the modulation control set at midpoint, you'll hear a fixed frequency tone determined by the initial pitch control. With the modulation control at one extreme of its travel the tone will start at the preset point but will sweep downward in pitch. The more forcefully the unit is triggered the higher the initial pitch; and the shorter the envelope decay the faster the pitch sweep. The modulation control can be thought of as an overall span control. The downward sweep is your basic Synare-type sound. With the modulation control fully to the other extreme, the pitch will start at the intial frequency but will sweep upward instead of down. This sound is quite novel, and not heard nearly as often as the downward shifting type used so frequently in radio and TV commercials. There is a jack that allows external signals to modulate the VCO so that you can produce vibrato (slow periodic shifting) or true FM, yielding great gong-like sounds. This jack is a switching type so that when an external signal is used the internal envelope is disconnected.

The noise source is a "back biased" transistor. The white noise produced by the transistor is fed to an op amp configured as a twin-T bandpass filter. The center frequency of the filter can be either set manually or swept by the internal envelope signal with the initial frequency control then acting as a filter range control.

As mentioned previously, the filtered noise can be mixed in any desired proportion with the oscillator signal before being sent to the VCA. The VCA is built around a CA3080 and has the same basic properties as Craig's VCA/VCD circuit in issue 1:8; however, it also adds another clever variation to the Drum's sound. Remember I said that the VCO only produces two waveforms? Well, on the waveform mix control there is a detent marked *Sine*. This position applies mostly triangle wave to the VCA, and kicks out an attenuator ahead of the VCA. This allows the triangle to overdrive the 3080; when overdriven, it rounds off the wave and produces a wave closely approximating a sine wave. The sine wave is very helpful if you want to imitate an acoustic drum and this circuit is really slick in its simplicity. Here again, the derived envelope drives a current source that drives the 3080 to yield final dynamics ; striking the sensor harder yields a larger amplitude output. There is a switching type jack ahead of the VCA that blocks out the VCO and noise sources, thereby allowing you to give percussive dynamics to external signals. The circuit essentially becomes a VCA under "strike" control and you can use any audio signal (like another band member's split signal, a microphone, or a tape recording). Because this part of the circuit is DC coupled (no capacitors), you can process *control* signals as well. The only thing to watch out for here is that if your control voltage is riding on an offset level you will probably push the 3080 up against a supply rail and cause clipping. You must also keep the input level of the control voltage to about .1V peak to peak to prevent the VCA from overdriving. After processing by the 3080, the control signal should come up to about 2V p-p. If this level is insufficient, extra gain can be added very easily (more on this later). The output current from the 3080 dumps through a resistor to create a voltage, which is buffered and then sent to the output jack via an output level control. Max output levels (using a ±9V supply) are about 2V for the square, 2.5V for the triangle, 3.7V for the sine and .2V for the white noise. These are all peak to peak readings. Disregarding the noise level, don't let the differing levels for the three waves fool you. Remember that the square wave with its large number of odd harmonics would sound (to the ear) very much louder than the pure (no harmonics) sine wave if it had the same amplitude.

"My wife Nancy was so intrigued with using [the Drum] that for the first time in five years, I had to cajole her to *leave* my workroom."

COMMENTS AND SUGGESTIONS

First, the white noise level is low for my tastes and should be brought up to the square wave level (or about 2V) in order to be really crisp sounding. Part of this problem results from using the back biased transistor design. It's simple and inexpensive but is device sensitive – no two transistors yield precisely the same output amplitude. The output level from this type of design is low to begin with, so gain must usually be added. In the Drum the twin-T filter

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BUILDING THE AMS-100

Here's a riddle for you...
Question: What has four jacks, is easy to build, and is very useful in modular systems like the AMS-100?
Answer: A multiple. "A What?"

MULTIPLES

This Month By JOHN A. FULTON

(Editor's Note: This month's module was scheduled to be the log VC LFO with sample-and-hold – but the Curtis CEM3340 VCO chip made the design obsolete. So, it's back to the breadboard. In the meantime, here's a "guest module" that is a versatile one-evening project. The switched multiple lends itself to many additional applications. As John accurately states, "...don't overlook this device." – Craig

A MULTIPLE IS A SERIES OF JACKS WIRED TOGETHER to form a mixing or distribution point. Figure 1 shows the "schematic" for what is called a Four-Way multiple. Easy, right? Sure it is! However, there are a few guidelines to keep in mind when using multiples.

1. Signals going into a multiple must be from a low impedence source. The 1K outputs in the AMS-100 work fine. Do not, however, short output stages together directly; they must be isolated through some kind of resistance.

2. The signal leaving the multiple must be to a high impedence input. The AMS-100's 100K inputs fill the bill.

3. Multiples normally work with high level signals (on the order of several Volts). Again, no problem for the AMS-100.

Figures 2, 3, and 4 should explain the applications of this circuit. Keep in mind, not only can you mix (with some limitations) and distribute control voltages, but the multiple will also work with high level audio signals...signals just like those put out by synthesizers and, of course, the AMS-100!

Now we come to the only real decision you have to make about this device, which is packaging. You could drill out a panel, mount the jacks and fit this "module" in your effects rack. However, I decided to build my multiple in a small plastic box (see figure 5). This way I have a floating patch-point that I can position wherever necessary.

If you decide on a panel mount, you might consider using a **Switched Multiple**. This will increase the fan-out of your first group of jacks or provide two, four-way multiples. See Figure 6.

Whatever you decide, don't overlook this device. It may seem useless at first, or you might feel that it's a waste of jacks. But in working with complex patches this thing can sometimes be the proverbial third hand.

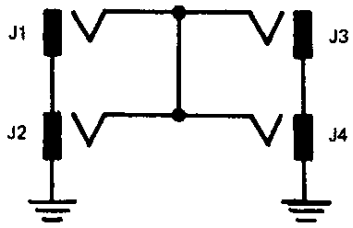


Figure 1. 4 Way Multiple

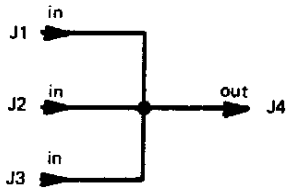


Figure 3. Mix

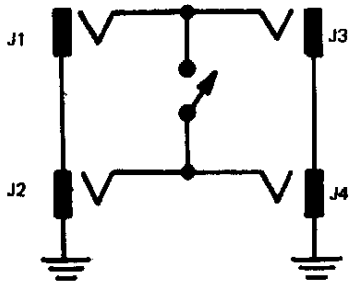


Figure 6. Switched Multiple

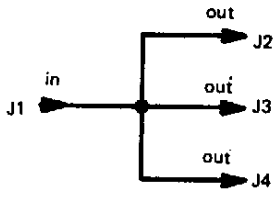


Figure 2. Distribute

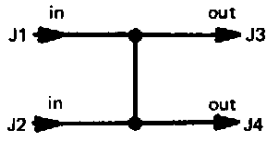


Figure 4. Mix and Distribute

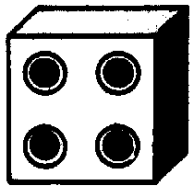


Figure 5. Multiple Box

the INTELLIGENT GUITAR

BY MARK HAMMER

THE LAST FEW YEARS have seen the emergence of what one might call the "intelligent" guitar. I don't mean anything snobish by this, but rather a guitar which includes on-board controls that allow for major or sophisticated changes in sound. I feel this is analogous to the "intelligent" computer terminal which does more than simply relay and display information from a larger computer.

Many of us grew up with but a simple volume and tone control, so much of the new guitar wiring technology is unfamiliar and somewhat untried. This article will present some guidelines for a sensible guitar, using the best that current technology has to offer without having it become an impediment.

PICKUP SWITCHING

Traditional guitars feature three way toggle or knife-throw switches to select between front, rear and both pickups (or combinations, in the case of 3 pickup guitars such as Strats or deluxe Gibsons). Additional easy-to-make modifications include cancellation of individual coils in humbucking-type pickups, change of phase relationships between the coils in one pickup or between two or more pickups, and tapping high impedance coils at various points along the coil.

In my experience, I have found that each of these three procedures will only work under certain conditions. For instance, on my own guitar (an older Epiphone solid body), I have a Strat layout of three pickups. I juggle back and forth with combinations of two Strat pickups, an old Melody Maker pickup and a recent DiMarzio 'Fat Strat'. I have a 3-way toggle to select between front/both/rear pickups, and an additional mini-toggle to switch the center pickup between in or out of phase, and off. Some combinations of pickups and locations do absolutely nothing when out of phase, while some sound like completely different guitars. For a pleasing out of phase sound, there should be about 50–70% overlap in frequency response between any two given pickups; more overlap and they cancel each other out almost completely, less and there is no cancellation (hense no effect). So, don't go router crazy just yet; you might find that some exotic combinations of pickups and phase relationships do nothing that you couldn't achieve by picking a little closer to the bridge.

Perhaps the biggest problem with coil cancelling and phase- reversal is an apparent drop in output, which can be very unnerving in a live music setting. Compression can help to even things out a bit but is not enough to completely compensate.

So, taking the above into account, the first important consideration for pickup switching is the acheivement of a noticeable difference in sound, while a second consideration is maintenance of constant volume.

"...the first important consideration for pickup switching is the achievement of a noticable difference of sound."

Consideration three is layout. I find too many people are going toggle crazy, and the guitar ends up looking like a combination lock. Your layout of switches should be such that it allows for easy duplication of sounds (remembering what the hell you did last time), fluidity of motion, and minimum chance of error. Don't situate toggle switches where you can inadvertently hit them on the downstroke; don't place them so that you might accidently move a pot when reaching for a switch, or visa versa. Plan to make it easy to switch pickups. My advise would be to figure out the half a dozen or so sounds you want and, more importantly, decide which are the most effective. Many of the sounds I've gotten through obscure combinations of pickups simply disappear when you turn the volume pot on the guitar down or the volume on the amp up.

PRE-AMPS AND BUFFERED STAGES

I think Craig has said enough regarding proper impedance matching between the guitar and succeeding stages so I won't retrace his steps. The buffering aspects of a pre-amp have also been covered in length.

One thing that has not gotten enough attention, though, is the gain aspect of an on-board pre-amp. Everyone these days wants that DiMarzio/Boogie sound – and I'm no exception – but for heaven's sake, why limit yourself to a thick fuzzy sound when tomorrow you might want to go Motown or Joe Pass? Leave yourself some slack, i.e., flexibility. If you insist on high output pickups, don't add any additional gain in your pre-amp but just buffer (especially you folks with old tube amps). The one exception I would make is if you are going into a box that requires line levels and has some insertion loss. Many of the special effects units such as phasers and envelope controlled filters (and I'm thinking particularly of E-H units) require very specific input levels which should not be exceeded if you want a predictable sound.

Another point is that whatever pre-amping you do should be clean, well shielded, and *securely fastened*. (I found that it was feasable to use a piece of double-sided copper clad board as both the PC board and the replacement back plate for my guitar. Cover the outside and etch the pattern on the inside. The outside copper can be used as shielding. This is quite secure and can circumvent the need for unnecessary routing or drilling. You may also be able to attach battery holders to it.) The point of a pre-amp is to cleanup your sound: If you can't add one without radically altering the guitar (and perhaps lowering its resale value) or making sure it's a *quality pre-amp*, then don't. Someone else may thank you in the end.

(continued on page 6)

ACTIVE FILTERS AND EQING

Whereas guitarists were once restricted to the simple treble rolloff control, they can now have continuous control of treble midrange, bass and points in between. To the guitar player with an older amp (like my tweed Princeton), on board EQing is just the thing to get past the restriction of the old style 'tone' control. It also helps to achieve tonal pre-emphsis for suceeding special effects (like phase shifters or envelope controlled filters). Another important consideration is the ability to change tonal settings in a live music setting without going back to the amplifier and risking feedback.

Many firms are now marketing modular style pre-amps (such as Roland and Intersound) with effects loops to eliminate the need for tonal pre-emphasis. Another source of redundancy that can occur is the turnover frequencies on the guitar and amplifier. Having Bass at 100Hz and treble at 10kHz on both the guitar and amplifier is a waste of time, If you can, try to have the turnover frequencies far enough apart so that you can have variety.[*The "Active Strat" tone controls I designed for Power Pots have dip switches to allow for corner frequency changes – CA*] A useful trick would be to have the tone controls on the guitar for frequency bands you are likely to want to change often, while having the controls on the amplifer for bands you are not likely to change during the course of a set. It may even suit you to simply have a wideband midrange cut and boost if there is a considerable change in sound from pickup to pickup. On my Epiphone, I have gone so far as to remove the tone control and install a 3-way toggle with one of two selectable rolloffs plus a straight feedthrough. It is simple, small, cheap easy to wire, and predictable! The size is important. You don't want to take up valuable space that you could use for something more important, like volume presets or whatever. If you have the need for 3 band EQing and you have the room for it, fine, but if you don't, why bother?

You might have seen ads for guitars with 3 band or 6 band equalizers but really, I feel they are a waste of time and money. First of all, the more active things you have inside the guitar, the more often you have to get inside and change the batteries. This risks damaging the finish, the screw hole threads, and your patience. I also wouldn't trust slider pots to have anywhere near the longevity of a rotary pot, or the freedom from dirt induced noise. It seems to me that many things like equalizers can best be done outside the guitar with AC adapters, parametric adjustment, and freedom from damage to the guitar.

COMPANDERS AND EFFECTS

To my knowlege, the Gibson RD series of guitars are the only ones with an active compander on-board. It is simple to use, not prone to errors, and of very good quality, however it *is a compromise* because Gibson has seen fit to give it a simple on/off action and also restrict the compressor and expander to specific pickups. Thats nice for some sounds but other people might want more flexability. (I adore the sound of a compressed bridge pickup, just like Jim Messina or Jeff Baxter) Once again, compansion is something that might be better done outside the guitar. A friend of mine put a MXR Dyna-Comp into his Les Paul, and it does sound like a sine-wave oscillator when he lets it ring. This arrangement works as both a compressor for each pickup or combination of pickups, as well as a buffered gain stage to fight against that first 10 foot cord from the guitar to the next stage. You have to realize though, that this requires either forsaking the tone controls or doing some routing, so again you have a choice to make.

I am personally quite shy of putting special effects into a guitar; my reasons are many-fold. There's the battery problem, the space-taking problem, the flexibility problem, and another aspect which I'll call the *novelty problem*. Seriously, how long could you stand to have a phase shifter right in your guitar at the loss of a master volume, midrange EQing, panning or anything elsethat might have a more lasting value. (If you read George Gruin's column in *GP* you'll know how whimsical additions to an otherwise classic guitar can lower its resale value simply because most people do not want an "altered" guitar. I hate to keep mentioning resale value, but I imagine at least a handful of you have to keep regularly selling your guitar to go back to school or pay for the dentist or your car.) MPC's Electra series has a nice idea in its plug in modules for different effects. This allows for expandability and ability to change with the trends but again, your limited to a fixed number of pots. [*I also question MPC's interest in updateing the Electra modules on any sort of regular basis. This brings in another problem with on-board effects systems like the Electra– you* must *use their effects and you must* like *their effects and* you must hope that the idea is enough of a marketing success that the company will continue to support it.–*RC*] Many of Craig's projects in *DEVICE, GP, CK* and commercial effects such as A/DA's use external control voltages so just like AC adapters, you can't have wires running back and forth from the guitar (unless you want to go to a mega-buck four channel wireless set-up). Another problem with on-board special effects is that you can't choose between a serial or parallel order of effects.

OVERVIEW

If you think that I am skeptical of "intelligent" guitars, that's not really the case. I am all for them...providing that they work. Try to put in only what you think will work sucessfully in a noticeable way. Make or buy an instrument that is laid out for you and for your purposes. If all you need is a Les Paul Junior or a Fender Bronco, by all means, use that; but remember that the proper choice of modifications can actually save you money if done right. It can give you the sound you always wanted from a guitar that felt good in your hand but not in your ear.

An extremely important question to ask yourself before buying an intelligent guitar or modifying your current one is "What am I going to use it for?" It's an important question because requirements for one setting may be unsatisfactory for another. If you wish to use your guitar for a live format, then you should consider the trade-off between speed and variety. For instance, a stock Fender Strat comes with a 3-way toggle which some people have replaced with a 5-way switch and even three 3-way switches, one per pickup. The later arrangement can give you more sounds but imagine yourself trying to switch from the front pickup to the rear pickup and back again with any accuracy or speed after owning the thing for only three months. I think the same problem occurs with switched pots; you can easily foul up your tone or volume settings. Again don't get me wrong; the Schecter assembly with switched pots for Les Pauls, for example, is a very smart and elegant notion. But, in fast moving situations, the "confusion factor" could affect your concentration and performance If you play a style of music that allows you the liberty of having plenty of time to switch around your sound, then clearly there is no impediment to using or installing more complex pickup switching or EQing.

If you are a studio musician then it is probably to your advantage to have a more versatile instrument to get "just that sound" the producer is looking for. It is also to your advantage,

(continued on page 13)

(continued from front page)

2. In order for the bucket brigade stages to pass information, the input must be biased up to approximately 40% of V_{dd}. In case of a +15 supply, this is +6V. The circuit in Figure 1 should be used to accomplish the biasing.

In the end, you will want to adjust the trim while observing the output on a scope. Adjust for no (or lowest) distortion with a full scale input.

3. Limit the input frequency to the SAD-1024 to less than $1/3f_C$, where f_C is the clock frequency applied to $\phi 1$ and $\phi 2$. By doing so you will minimize "foldover" distortion in the output. An active filter stage could easily be cooked up to lowpass everything up to $1/3\ f_C$, and at the same time increase or reduce the input level of the necessary 500mV p-p, (see above). This bandwidth limiting is *not* a trivial matter, and is vital to getting the output to sound clean.

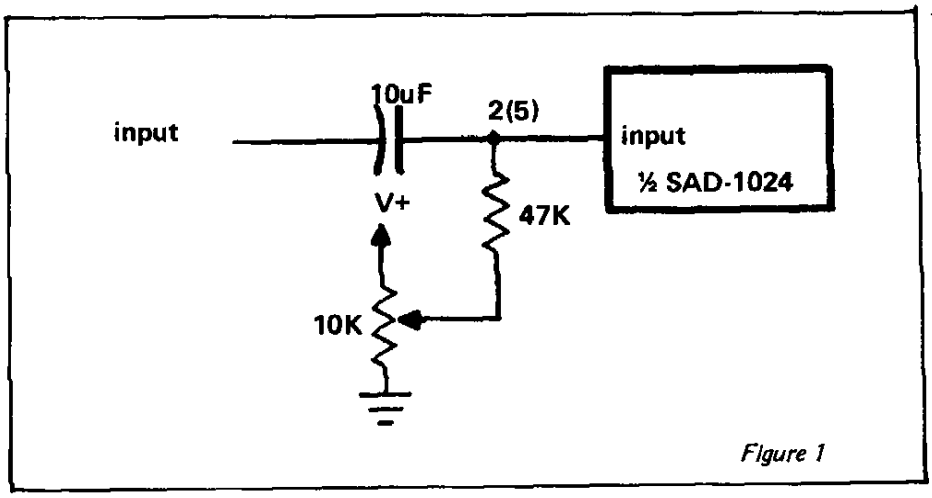


Figure 1

OUTPUT CONSIDERATIONS

4. The outputs of one section of the SAD-1024 can be terminated in either of the following two ways shown in figure 2.

This brings up an important point. There *must* be an output load. Of the above, the transistor output gives better results. The 1K trim is adjusted until the outputs (viewed on a scope) "come together", and have the same amplitude. This minimizes clocking glitches also.

5. The gain of the stage depends directly upon the load resistance, and in general you can expect it to be greater than unity. (a 10K resistance, not a practical load by the way, gives a gain of 1.2). Since there is a gain in general, if you are planning upon serial operation (tying two stages together in series), you must attenuate the output of the first stage somewhat, to attain the input requirements, (mentioned above), for the next stage. Figure 5 (located on page 16) fills the bill.

By the way, this is a good time to remark that all unused *outputs* should be tied to V_{dd}. For more on this read on.

6. The output should also be lowpass filtered, with a cutoff of at least $1/2f_C$, with $1/3f_C$ being preferred. This filter serves two purposes. The first is to remove the residual clock glitches, and the second is to smooth the stairstep output into a close approximation of the input. This smoothing is directly related to the cutoff slope. In the spec sheet, Reticon recommends a cutoff slope of 36dB/octave, but I think in general that a four-pole (24dB/oct.) is adequate. We might note in passing that pre-emphasis and de-emphasis isn't a viable way to reduce noise in view of the aforementioned remarks concerning foldover distortion. The very process of pre-emphasis violates the input filtering requirement. What we need is less high-end response at the input of the SAD-1024, not more.

POWER SUPPLY CONSIDERATIONS

7. The SAD-1024 can function over a wide supply range, with best results when it lies between +9 and +17V. +15V is the preferred supply voltage as all parameters maximize here. Another reason for preferring the +15V supply is that at other voltages the clock amplitude and input biasing must be adjusted considerably. This can be a real hassle, so stick with a standard supply. [*There is also something to be said for running the SAD-1024 at a lower voltage than the clock voltage – see the Flanger in DEVICE 1:9 – CA*]

To keep clock noise from getting into the supply lines, bypass the chip in the following way:

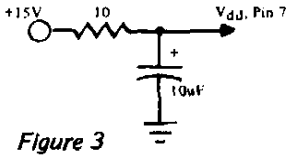


Figure 3

8. V_{bb} (which supplies a voltage to the bias line) is required for some versions of the SAD-1024 and can be provided by the +15V V_{dd} voltage, however the spec sheet claims that best effeciency is obtained when V_{bb} is one volt lower than V_{dd}. The following voltage divider does the trick:

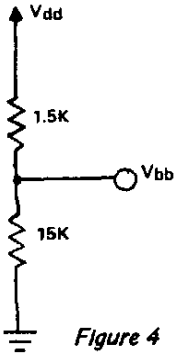


Figure 4

9. V_{dd}, V_{bb}, and ground pins, (7,9, and 1 respectively) are common to both stages of the SAD-1024.

(continued on back page)

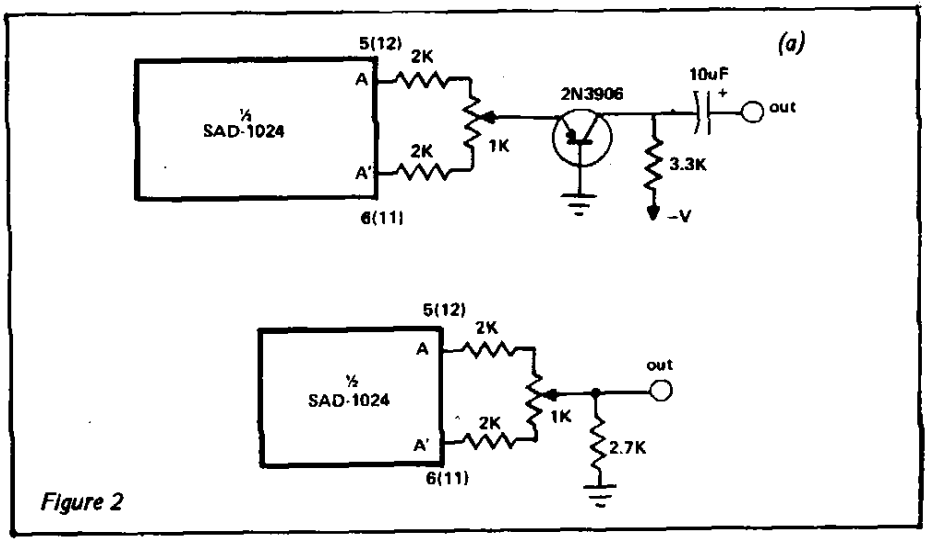


Figure 2

CURRENT EVENTS
CURRENT EVENTS

MODULATION PEDAL

Synthetic Sound Labs (P.O.Box 668, Brenton Woods, NJ 08723) is introducing a modulation pedal for synthesizers with a built-in LFO. It is intended to plug into any system with an external control voltage input. For information on availability and pricing, write to the above address.

MINIATURE AUDIO CONNECTORS NOW AVAILABLE

Switchcraft now offers the Tini Q-C line of miniature audio connectors. These are similar in function and shape to the standard XLR connectors, but are about 1/3 the size. In addition to the usual three pin versions, four and five pin versions will also be available. Contact your nearest Switchcraft distributor for further information.

ALTERNATIVE NOISE REDUCTION ON THE WAY

Telefunken's new noise reduction system offers 20dB of noise supression over the 20Hz to 20KHz range, and the company hopes to supplant the Dolby system in consumer and studio applications. So far, industry response has been quite good - we might see these systems showing up in consumer equipment within the year.

STOP BLOWING UP YOUR CIRCUITS.

According to an item carried in the "Engineer's Newsletter" section of the March 27, 1980 issue of *Electronics* magazine, the **Long Range Company** (P.O.Box 911, Amado, AZ 85640) has developed a circuit breaker for use with breadboards that can trip at 10 mA, 250 mA, 500mA, 1.2 A, and other currents. This sounds like a good way to prevent blowing up expensive ICs, but will set you back around $50. For further information, write to the above address.

SPEECH SYNTHESIS GOING FULL STEAM AHEAD

Now **Motorola** and **National Semiconductor** have jumped on the speech synthesis bandwagon. This gives even further credence to the idea that before too long, all our little electronic toys will not only flash numbers at us, but will talk to us as well. Those of you who have played the *Gorgar* pinball machine are getting a taste of the future...

MXR INTRODUCES STEREO SYSTEM PREAMP

The **MXR System Preamp** (see photo) is designed to offer the stereo enthusiast control capabilities usually found in tradional recording consoles. The System Preamp lets the user route two simultaneous signal sources independently to a monitor, tape output, or power amp and speakers. A mix control blends the two signals and permits fading from one source to another. An additional instrument input jack enables electronic instruments and microphones to be blended with the program material (shades of the "Practice Play Along!). Optional rack ears are also available.

SPEAKING OF MXR...

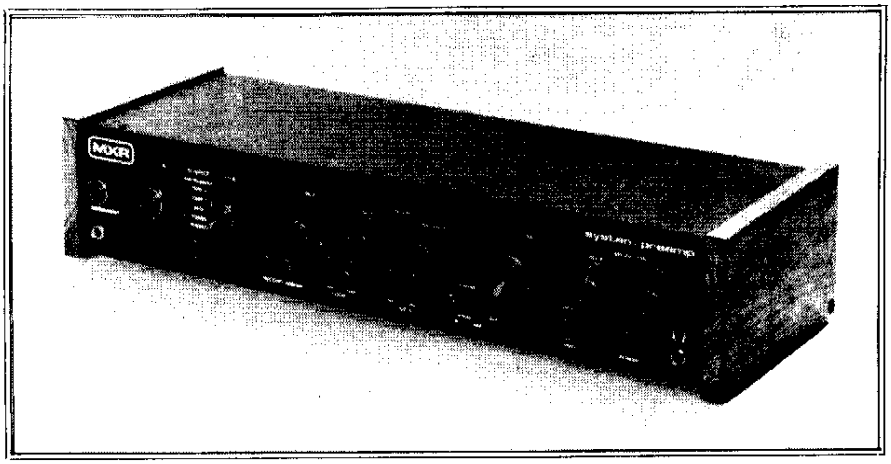
Discussion + is a new quarterly newsletter published by MXR, 740 Driving Park, Rochester, NY 14607. Copies are available upon request, and there is no charge. Topics include applications of MXR effects, new products, and other items of interest to owners of MXR equipment. Tell them you heard about it in **DEVICE**.

RMS-TO-DC CONVERTOR CHIP

The **Analog Devices** AD536A performs RMS-to-DC conversion. While intended for Voltmeter applications, this chip should be ideal for accurate noise reduction systems, envelope followers, and other electronic music applications.

SOLID STATE MUSIC BOX CHIPS

Panasonic has developed the MN6221, a mask programmable CMOS chip capable of generating several musical melodies. It is intended to produce an audio output for device such as alarms, clocks, doorbells, music boxes, toys, ect. **General Instruments** offers the AY-31350, a similar device that generates up to 28 tunes of up to 252 notes, but can also generate tunes from data held in external PROMS.



If you have new products, information on new components or new suppliers, interesting tidbits, press releases or just some juicy gossip, tells us! We love a good scoop. Address it to Current Events, c/o DEVICE, 1085 Broadmoor Drive, Napa, CA 94558. Or if it's particularly hot give us a call at (707) 226-8428.

DEVICE IS FUNDED IN PART BY A GRANT FROM PAIA ELECTRONICS

PAIA IMPROVES CUSTOMER SERVICE

Bob Ess is now in charge of customer liaison for **PAIA Electronics**. His job supplements that of tech services by expediting customer problems or questions of a non-technical nature.

A NEW D.I.Y PUBLICATION IS BORN

The people who bring you *the Audio Amateur* have launched a new publication dedicated to the do-it-yourself audio speaker builder called, aptly enough, **Speaker Builder**. Published quarterly, **Speaker Builder** covers all aspects of speaker design, theory, application, and craftsmanship. Those of you already familiar with *the Audio Amateur* can look forward to a publication of the same qualitiy and editorial content. If your looking for a source of accurate ongoing information on speaker design and construction, look no further. Highly recommended. *Speaker Builder* subscriptions are $10 per year. Single issues may be purchased at $3 a piece. Foreign readers, inquire with *Speaker Builder* about their special foreign rates. Address all subs and inquires to: P.O.Box 494, Peterborough, NH 03458.

INEXPENSIVE CONDUCTIVE PLASIC POTS ON THE WAY

Bourns is introducing a low cost line of conductive plastic pots that sell for approximately $1 a piece in large quantities.

NEWSLETTER FOR SYNTHESIS ENTHUSIASTS

Synex (P.O.Box 294, Corte Madera, CA 94925) is an excellent little publication that offers record reviews and serves the function of an idea exchange for synthesists. Those of you who are intrigued by all the independent lable music going around these days, but are not sure whether to plunk down the bucks on something you haven't heard, will no doubt find their reviews most useful. The general slant is towards the philosophy of new music as opposed to covering the hardware, and as such fills a "hole" in the electronic music field that no other publication is really addressing. For further information, contact Chuck Larrieu at the above address.

A CORNUCOPIA OF SCHEMATICS

The **Electronotes Building Guide and Preferred Circuits Collection** is available for $8.50 to *Electronotes* subscribers and $12 to non-subscribers. This is sort of an *"Electronotes Greatest Hits"* collection of circuits and tips that is highly recommended to anyone who builds their own devices. By the way, if your thinking of subscribing to *Electronotes*, now is the time...rates for Volume 12 (1980) are currently $18, but after July 1st, the price goes up to $25. If you want to save more bucks, you can order the 1980 and 1981 volumes for $33 before July 1st ($45 thereafter). Write to Bernie Hutchins at *Electronotes*, 1 Pheasent Lane, Ithaca, NY 14850, and tell 'em **DEVICE** sent you!

AUDIO CHIP FOR THE 1802

The **RCA** 1802 microprocessor is very popular with hobbyists. Now, a matching audio chip, the CDP1869, generates 128 tones over an 8 octave range (not chords, though) along with white noise. These cam have envelopes quantized to 16 steps.

MORE ON-BOARD ELECTRONICS FOR GUITAR

Zeta Systems [*the manufacturing/marketing end of the Zetaphon polyphonic guitar synthesizer group — RC*] is announcing the release of their new on-board signal processing module for guitar called (get ready for this), the **Little FEANC** (that's pronounced FINK!). Deriving its name from the intials of the effects the module offers (Fuzz, Equalizer, Amplifier, Noisegate, Compressor), the unit is designed to fit into any guitar replacing the existing controls. The little FEANC retails for $149.95. For more information contact Keith McMillen at Zeta Systems, 1122 University Ave., Berkeley, CA 94702. Or call direct: (415) 848-7728.

BUFFERED VOLUME PEDAL NOW AVAILABLE

Goodrich Sound Co. (12571 Lincoln St., Grand Haven, MI 49417) is offering the Series 6000 footpedals which include built-in buffering to insure high input impedances (2M typical) and low output impedances (1200 Ohms typical). These are available in both photocell and potentiometer types.

DRUMMERS STRIKE BACK

(continued from page 3)

adds gain but the problem here is that with too much gain the filter quickly becomes an oscillator — not cool. All is not lost, however, because there is a spare op amp right there on the board which is meant to be used as a mixer in the four channel system. Just make sure that you amplify the output of the filter, not the input *to* the filter, or else oscillation may occur.

Most ICs have excellent hum rejection; the noise transistor doesn't, so with some power supplies hum may creep into the noise output. If this happens, use a 100 Ohm resistor in series with each supply lead and a 220 uF capacitor to ground off each resistor (½ Watt types) observing polarities. You may want to include diodes as protection against reversing the power supply leads that would otherwise fry the ICs if the diodes weren't there. The manual cautions against polarity reversal, and there is a notched molex connector for the supply leads, but it doesn't hurt to be safe.

Performance-wise, there is only one anomaly that bothers me — and again it concerns the noise filter. When bandpass filters are hit with a spike (in this case the fast rising percussive envelope) they ring or produce a damped sinusoid output wave. This happens most notceably when the noise filter is in the swept position. A short pronounced blip is tagged on ahead of the noise and this will be unacceptable if your trying certain forms of cymbal synthesis. There are several things you can do to avoid this. First, you can actually use this anomoly to your advantage; by setting the decay envelope to a short period, you can actually "play" this filter as if it were a crude oscillator. You can also route the noise out of the unit and filter it with a similar or different control signal. It may also be possible to insert a lag (RC) network in the control line to this filter to minimize the ring effect, although I haven't actually tried to do this.

Do not get the idea from the above, however, that the Drum is deficient. My wife Nancy was so intrigued with using this circuit that for the first time in five years, I had to cajole her to *leave* my electronics workroom. The Drum will produce a great variety of effects. The applications (and possible modifications) of this unit are so large that another full article would be needed to list them, and even then it might be only skimming the surface.

(continued on page 13)

DIALOGUE

DIALOUGE is the place in DEVICE for **you** *to get your two cents in. The comments and suggestions have been instrumental in us creating a publication that truly answers your needs and gets your ideas and interests out to those of a like mind. Tips, love letters ,crank mail, or what ever should be submitted to DIALOGUE, c/o DEVICE, 1085 Broadmoor Drive, Napa, CA 94558.*

LOOKING FOR BOOKS

I am interested in the field of electronic music circuit design. Do you know any good books on this subject?

Randy Flatness
San Luis Obispo, CA

Randy — There aren't any books on electronic music circuit design, which is one of the reasons for having a regular feature in DEVICE that addresses this subject. However, you can learn alot about circuit design by following articles in DEVICE as well as in **Electronotes, Polyphony, Popular Electronics,** *and the various data books offered by manufacturers. Also don't forget to study all phases of circuit design if possible; ring modulators, for example, stem from radio frequency technology.*

CHEAP GUITAR/SYNTH?

I was wondering if I could interface a PAIA Gnome Micro-Synthesizer to guitar. Is it possible?

Rick Ratta
Malden, MA

Rick — See my artical in issue 4/76 of **Polyphony** *magazine. Bear in mind that you won't get any pitch to voltage conversion for driving oscillators, and that the sound quality will not be up to something like the AMS-100, but this is a fun way to get started in guitar synthesis that won't exhaust your pocketbook.*

WHERE'S SYNAPSE?

Do you know what has happened to *Synapse*? I still have not received any reply from them about my subscription. Also, how about a 50 to 100 Watt power amp design?

Raphael Walron
Trinidad, West Indies

Rapheal — Untill I see otherwise, **Synapse** *is no longer in business. I apologize to those people who have subscribed based on my mention of the publication; of course I had no way of knowing that they would not make good on subscriptions if they folded (most magazines send a refund, or allow for the remainder of a subscription to be filled by another magazine). Hopefully magazines like* **Polyphony** *and DEVICE will take up the slack left by the absence of* **Synapse.**

Re power amps...one of our friends in India has sent in a diagram for a power amp, which we hope to publish soon. We had been promised a power amp design by another subscriber, but that fell through. In the meantime, for low power applications see the "D.I.Y. Power Amp" article in DEVICE 1:10. Also, Jack Darr's **Electric Guitar Amplifier Handbook** *(published by Howard W. Sams) contains a great number of schematics and information on commercially available guitar amps. It is available for $10.50 plus $1.50 shipping and handling from Polymart, P.O. Box 20305, Oklahoma City, OK 73156.*

DEVICES AND RECORDERS

One problem I've had with all guitar devices is in trying to feed them line levels from a tape recorder for use as a studio unit. Would a resistor solve the problem, or a buffer board, or what?

Roger Zumwalt
Venice, CA

Roger — The basic problem is that most units are designed to accept low levels inputs, while tape recorders put out high level inputs. Your best option is to hook up a 50k volume control between the recorder output and the effect input (the hot terminal of the pot goes to the tape out, the middle terminal of the pot goes to the effect input, and the remaining terminal goes to common or ground). Turn down the control until distortion goes away, and you're in business. However, remember that because you're padding down the input, you will find it necessary to re-amplify the effect output in order to bring it up to line level again.

HELP!

Can any reader send me information on the Maestro *Universial Synthesizer System*? Any type of information would be appreciated, especially a photocopy of the manual. I only have the box itself, and don't know what devices plug into the external connectors.

Keith Fretz
1947 Gregg Ave.
Reading, PA 19607

TRANSFORMER SUBSTITUTION?

Can I use a 34V center tapped transformer with the modified hefty power supply described in DEVICE 1:3? This is easier to find than the 30V center tapped model specified in the article.

A final note — I ordered an EXAR grab-bag from JAMECO Electronics for $4, and it contained, among other things, eight 4739s and three 4136s, whose regular cost would have been $11.80. You might want to check this out.

Stephen Richards
Baltimore, MD

Yes, you can use a 34V type, although you might get a little more heat dissipation in the regulators. If this is a problem, insert a low value (a few Ohms) high wattage resistor between the rectifier diodes and positive/negative filter capacitors.

AMS-100 SUMMING NODE

With the AMS-100 VCA/VCD you use a 2N3906 transistor with the base grounded as a summing node for the intial gain and external control voltage. How does this differ from the more common summing nodes using a negative feedback op amp?

Bob Jacobs
New York, NY

On-board Electronics

Low Noise Preamp Input Stage

By Craig Anderton

On board electronics for guitar need to be as quiet as possible. The following describes a technique I used during the design of the Power Pots [*P.O. Box 896, West Covina, CA 91793 — RC*] Model II Preamp; you may be able to use it in your own circuits when you need low noise and high impedance.

First, this technique only applies to signals feeding the non-inverting (+) input of an op amp. Normally, signals couple into this input through a resistor and a capacitor as shown in Figure 1 (see the *Electronic Music Circuit Design* or *EMCD* for short, columns on op amps for more on the subject). However, here we have a dilemma. In order to have a high input impedance, then we should use a high value resistor at the input — around a Meg or so. But as you might recall from our discussion on noise in *EMCD* Part 2, a high value resistor generates lots of noise as well as being susceptible to radio frequency interference and hum.

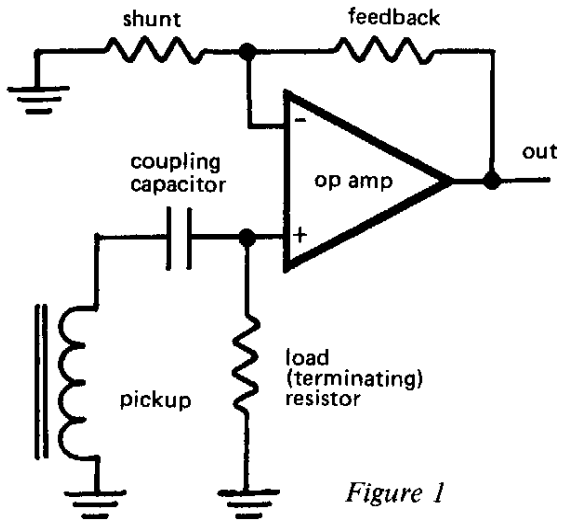


Figure 1

Figure 2 shows the solution. By terminating this input directly through the guitar pickup and eliminating the coupling capacitor, we have gained three significant advantages. First, by removing the coupling cap we have excellent low noise frequency response and minimum phase shift. Second by not having any load resistor, the pickup "sees" no load other than the non-inverting input of the op amp, which typically has an impedance of several million Ohms (which goes even higher with bifet types). Third, the input of the op amp terminates to ground through a low-resistance source, namely the pickup itself. This means as far as the op amp (+) input is concerned, it "sees" a resistance to ground equivalent to the resistance of the pickup, which is typically a few thousand Ohms. Luckily for us, this low a source impedance produces excellent noise results.

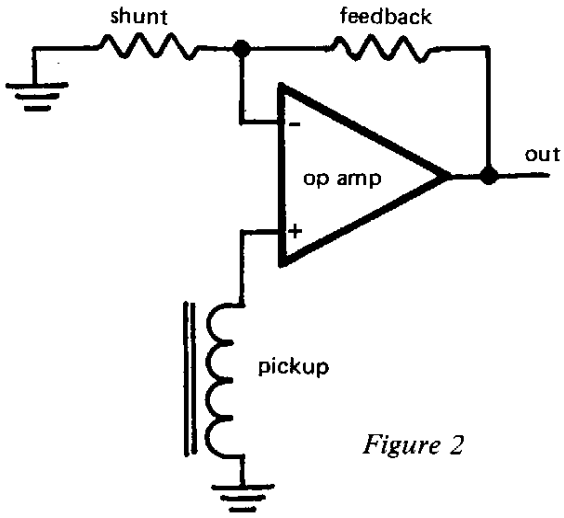


Figure 2

If you're interested in running an experiment, try breadboarding a preamp stage using conventional capacitor coupling and a 1M load resistor. Then, try coupling the pickup directly into the non-inverting input. The difference in noise level will astound you...it sure astounded me!

—Craig

Bob — I used that particular configuration because it's cheap and works OK for non-critical DC summing applications where you want a current-controlled output. However, I would not suggest this for any kind of precision application...we're just dealing with a "quick and dirty" approach in this instance.

Those interested in building project Number 3 in *EPFM* may have been frustrated in attempting to find the specific inductor, since Radio Shack no longer stocks this part. However, Calectro sells an equivalent miniature audio driver transformer, 10k to 2k. Physically it is slightly smaller than the Radio Shack transformer. The primary measures about 500 Ohms, as does the primary of the Radio Shack transformer. The Calectro part is number D1-711. (Calectro parts are sold nationaly through many electronics outlets. For information on the store nearest you you can contact Calectro through GC Electronics, a division of Hydrometals, Inc. Rockford, Ill. 61101.)

Carl F. Hartman
Newport Beach, CA

IS THIS STUFF TESTED?

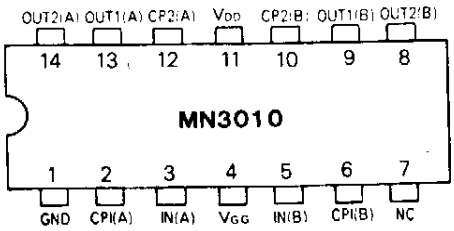
How about more pictures...if you actually implement one of your circuits, why not show the final product?

Jim Elsworth
San Francisco, CA

Jim — Basically, pictures drive up the cost of printing, as well as requiring a fair amount of time to set up and get develope. We'd like to have more pictures too, and will add them as finances and time permit. By the way. all circuits are implemented; we don't run anything unless it works for us.

DEVICE IS FUNDED IN PART BY A GRANT FROM BILL GODBOUT ELECTRONICS

Terminal Assignments



filespec. **Computer-ese for file specification and the heading for our continuing series dedicated to component information. *filespec*'s purpose is to give you a database from which to do your own experimentation. This page is designed to be photocopied, punched and filed. If you need further information on anything mentioned in *filespec*, drop us a line. We'll be glad to help you out.**

In this installment Dave gives us the rundown on another of the Matsushita delay lines the MN3010. Dave will be making the majority of the components covered in this series available through E-Systems, P.O. Box 5305, Berkeley, CA 94710. Write for his price list.

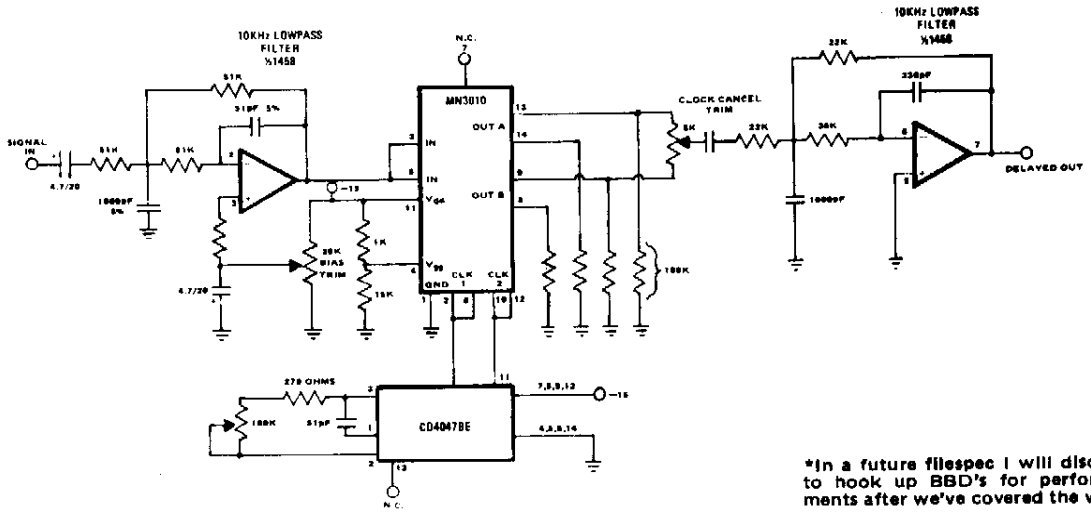
filespec:MN3010

The Matsuchita MN3010 is a dual 512-stage Bucket Brigade Device (BBD) with a useable delay range from 0.3 msec (at f_{cp} = 850KHz) to 32 msec (at f_{cp} = 8KHz). Because of its delay range it is an excellent choice for flanging and chorus effects. When used in a parallel multiplex configuration*, as shown in the schematic below, the best signal-to-noise ratio of all available BBDs (Reticon SAD-1024 included) can be achieved. As with most P-MOS BBDs, the frequency response falls short of full audio bandwidth (15KHZ), but this can be overcome with a little pre-emphasis.

There is a DC bias level shift at the output which is clock frequency dependent and becomes noticeable at around 350KHz and above.

The capacitance of the clock lines is not so high that the CMOS 4047 will not drive it sufficiently. (Although MOS clock drivers would enhance the performance.) Please note that the P-MOS BBD runs off −15V, so that the 4047 must also run off the −15 and ground. All the capacitors below are .01mfd in value and the resistors all have a 5% tolerance.

—Dave



*In a future filespec I will discuss various ways to hook up BBD's for performance enhancements after we've covered the various types. *DT*

	MIN	TYP	MAX	UNIT
Drain Supply Voltage, V_{dd}	−14	−15	−18	V
Gate Supply Voltage, V_{gg}	–	V_{dd}^{+1}	–	V
Clock Frequency, f_{cp}	8	–	850	kHz
Input Signal Frequency [f_{cp} = 40 kHz, V_i @ 1.8 V_{rms}, −3dB point with 0dB ref @ f_i = 1kHz]	–	–	14	kHz
Input Signal Swing, V_i	–	–	1.8	V_{rms}
Insertion Loss [f_{cp} = 40 kHz, f_i = 1kHz]	–	0	–	dB
Total Harmonic Distortion, THD [f_{cp} = 100kHz, "A" weighted]	–	0.4	–	%
Signal to Noise Ratio, S/N	–	85	–	dB

INTELLEGENT GUITAR

(continued from page 6)

to get those sounds quickly without having to go to an overdub. Furthermore, a guitar that is capable of going straight into the board with full EQing or overdrive is a nice feature. But if you do a poor wiring job or have switches and their connecting wires all over the place with lousy shielding, then you aren't doing anyone any favors.

I have yet to find an arrangement on my guitars that I find really suitable, so I can't describe the definitive intelligent guitar. But, I can give some tips. Pickup switching systems are your first priority. This is the only thing you can not do off-board. Furthermore, there are some combinations of pickups and phase relationships that you will never duplicate with any sort of active EQing. Try to install a master volume control that you can reach in a handy fashion. A volume control in the hands of a competent player can be a special effect in itself. Try to buffer your output with an active buffer or, if you can find it, a suitable transformer. As for EQing, you might find that with a sophisticated enough pickup switching system, you may only need one high or low shelving equalizer. If you have a double tone/volume set-up for a two pickup guitar and you want to get into active electronics, it might be better to have a switching pot that allows either treble or bass shelving. This leaves you three more holes to install a master volume pot and separate preset volumes, which may come in handier in the end. Don't route until you are fairly sure you want this modification (remember the resale!), and you want it for keeps. You may route yourself out of another alternative in the process.

Ideally, what I would like to see is some kind of CMOS/digital system installed. This would do several very nice things. First, it would allow you to situate your switches or pots where you want them rather than where they will be best shielded. Furthermore, we may be able to have programmable guitars. Programmable? How? Well, for one thing we could have something like the current state of polyphonic synthesizers with numbered presets and a digital display to indicate status. Sounds crazy, but imagine how nice it might be to be able to touch one button and go from the middle pickup out of phase with the other two pickups to just the front pickup by itself or go from front pickup/first coil to second coil on all pickups. We might also be able to use voltage control for volume and have preset pick- s *and* volume settings. Pipe dreams, for sure, but if it could simplify the things we can already do with toggle switches and pots, plus make the instrument more playable, then why not?

I'll probably kick some dust off this article, and hope some of it is creative dust. As Craig has mentioned before, companies are starting to take notice of publications like **DEVICE**. Perhaps it won't be long before someone turns out a programmable guitar. For now, be practical, buy practical, and build practical...it will pay off.

—Mark Hammer

DRUMMERS STRIKE BACK

(continued from page 9)

For those who are interested I would urge you to contact PAIA and at least purchase the manual to get a feel for the versatility of this unit. Send your comments or mods to Steve Wood (the designer of the Drum) as he has been quite helpful and surely will appreciate your responses. In closing, if there is any one thing I regret about the Drum, it's that I only had one to work with and not the full four channel system. Oh by the way, you don't have to be a drummer to have fun with this circuit, just let your imagination go...the possibilities are waiting for your "touch".

The DRUM is available from PAIA Electronics, Inc., P.O. Box 14359, Oklahoma City, OK 73114. Cat. No. 5700 single Drum card kit is $59.95 (postpaid) and $89.95 assembled. Four channel system kits are $269.75 postage paid.

DIALOGUE

(continued from page 11)

NEW EPFM?

Where can I order a copy of Craig Anderton's revised version of *EPFM* (*Electronic Projects for Musicians*)?

Peter Hanson
Waterloo, Ontario, Canada

Peter — The revised version will not be out until August at the earliest, and possibly not until the beginning of 1981. In the meantime, the first edition is available for $7.95 plus $1 handling from either Bill Godbout Electronics, Bldg. 725, Oakland Airport, CA 94614, or Polymart, P.O. Box 20305, Oklahoma City, OK 73156. It is also available from a number of music and book stores. Call up some of the stores in your area and see if they have it in stock. Both **Electronic Projects for Musicians** *and* **Home Recording for Musicians** *are published by Music Sales, 33 West 60th St., New York, NY 10023.*

SOURCE FOR STK054

In regard to Craig's article in DEVICE 1:10, both the STK054 and 056 power amp modules are available from MCM Audio, Inc. (639 Watervliet Ave., Dayton Ohio 45420). These are Sanyo rather than Sony, but I think they are the same quality. Prices for either module in the most recent catalog are $10.40 for less than 10 pieces, $9.40 for 10 - 25 units, and $8,40 each for 30 units and up. Minimum order is $20. MCM also offers many bargins on Sanyo transistors (see the May 1980 *Radio-Electronics*). Thanks for DEVICE; keep up the good work.

Bob Eiser
Toledo, Ohio

GOT AN IDEA?

Let us know about it! Turn your ideas into reality and $. We, at DEVICE, are looking for good ideas for modifications, interesting ki and informative books and pamphlets. Let us help you bring your project to market. Write us and write for us!
DEVICE WANTS YOU!

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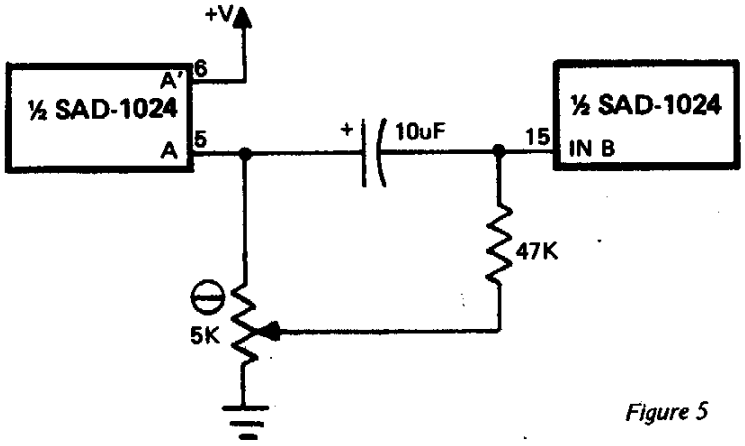

Figure 5

STALKING THE SAD-1024

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10. As mentioned above, all unused *outputs* should be tied to V_{dd}. However, all other unused pins, *including those marked NC*, should be tied to *ground*. These requirements are easy to forget, so make a special note of them now.

[This concludes Part One of Tom's article on the SAD-1024. Part Two will be in your mailbox NEXT MONTH! Stay Tuned!!]

NOTES AND SOURCES FOR *STALKING THE SAD-1024*

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ADDRESSES

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