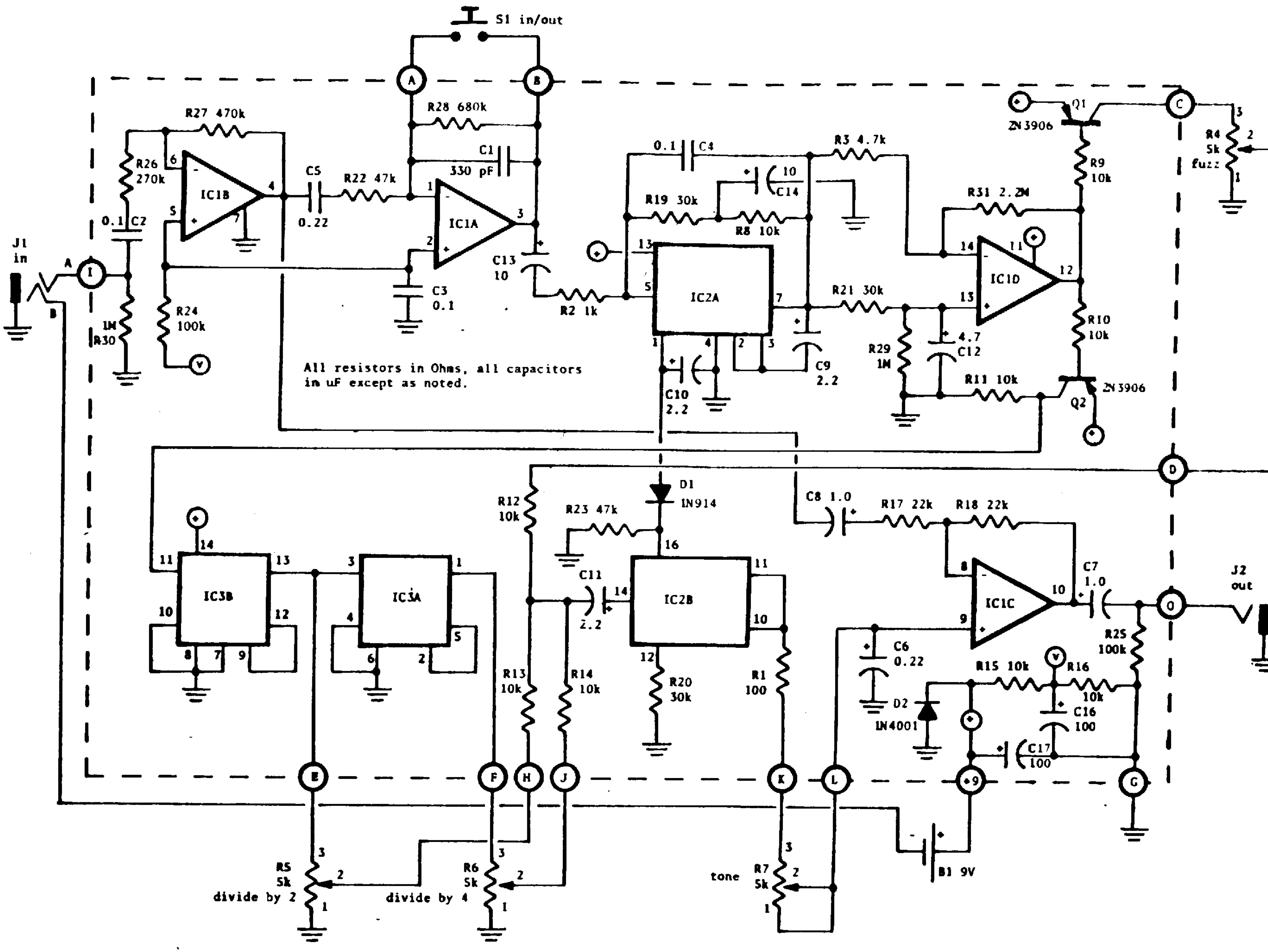

S1 in/out
R27 470k
R28 680k
C1 330 pF
R26 270k
IC1B
C5 0.22
R22 47k
IC1A
0.1 C2
C3 0.1
C13 10
J1 in
R24 100k
1M R30
0.1 C4
R3 4.7k
10 C14
R19 30k
R8 10k
IC2A
R2 1k
R21 30k
C9 2.2
C10 2.2
R29 1M
4.7 C12
R11 10k
Q1 2N3906
Q2 2N3906
R9 10k
R31 2.2M
IC1D
R10 10k
R4 5k fuzz
All resistors in Ohms, all capacitors in uF except as noted.
D1 1N914
R12 10k
R23 47k
C8 1.0
R17 22k
R18 22k
IC3B
IC3A
C11 2.2
IC2B
IC1C
C7 1.0
J2 out
R25 100k
C6 0.22
R15 10k
R16 10k
C16 100
C17 100
D2 1N4001
R13 10k
R14 10k
R20 30k
R1 100
R5 5k divide by 2
R6 5k divide by 4
tone R7 5k
B1 9V

Fi

Build The Roctave Divider

New Sounds, More Versatility

By Craig Anderton

I'VE BEEN FOOLING around with octave dividers for a long time, but I never had anything which I considered quite good enough to put into print—until now. The Roctave Divider not only does what traditional octave dividers do, but it also has a few other tricks up its sleeve. For example:

Multiple Sounds

You can mix any proportion of octave-lower sound (original frequency divided by two), two octaves-lower sound (divided by four), or normal fuzz sound (at the fundamental frequency), along with the straight sound.

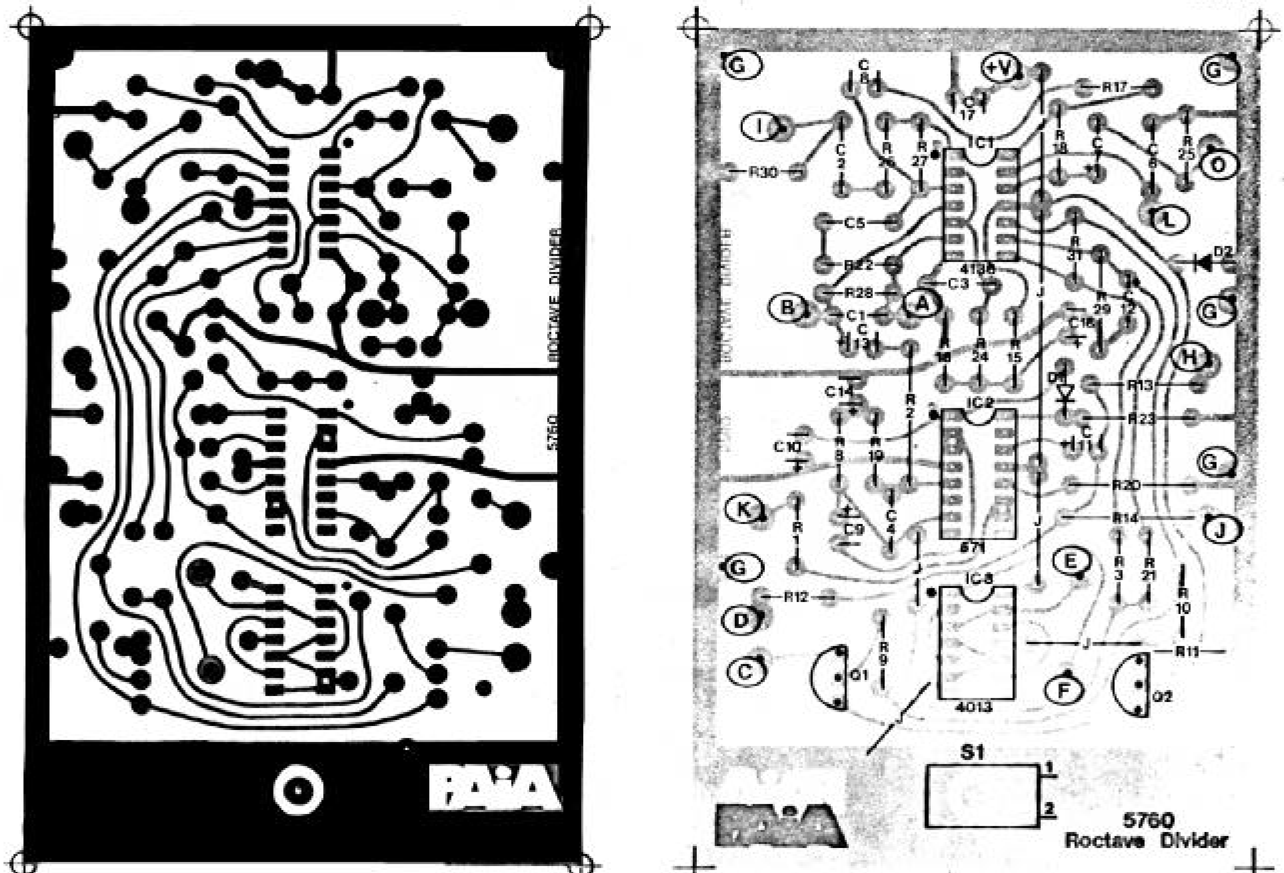
Sustain-Plus-Decay Dynamics

All of the aforementioned sounds have a sustained, compressed character *until* your string hits its final stages of decay. Then, as the string fades out, the level of the divided and/or fuzzed sound tracks your instrument's dynamics for a more interesting, life-like sound.

Sputtering

No "sputtering" at the end of notes. Generally speaking, octave dividers cannot track extremely weak signals. So as a note fades out, simple octave boxes tend to produce an annoying, sputtering kind of effect. However, the dynamics-generating part of this

continued



Left: The full-size foil pattern negative for etching a Roctave Divider printed circuit board. Right: Parts layout for the circuit.

circuit is designed so that the divided signal decays at a slightly faster rate than the note you're playing. Thus, the divided signal disappears *just* before the point at which sputtering would normally occur.

Tone Control

When pulled back all the way (minimum treble), you can get Wes Montgomery-like sounds which are mellow and, thanks to the decay dynamics, extremely natural-sounding. But set the tone to 10, and you'll get a raspy, fuzzy, sustained sound which is about as rock and roll as you're going to get.

Good Tracking

I won't claim that a circuit this simple is perfect, but it does work extremely well (of course, like other simple octave dividers, the Roctave Divider tracks only single notes, not chords). In fact, if you use your bass pickup, and remember to pick lightly whenever fingering below the 5th fret or so, you'll have good-to-excellent tracking over the entire range of the neck. Above the 5th fret, you can get pretty wild, and the thing will still track well (although at the very highest notes you may have to hit the strings a little harder than usual). For those with a lighter- or heavier-than-average touch, at the end of this column we'll describe how to customize the Roctave Divider to make the best possible match with your playing style.

Simple Power Requirements

The Roctave Divider works off as little as 6.5 volts to as much as 12 volts DC, so a 9V transistor radio battery makes a good power source. It draws less than 10 milliamperes (10mA), and typically about 7mA or so.

How It Works

Referring to the schematic diagram (Fig. 1), J1 is the input jack. When you plug a standard mono cord into this stereo jack, lug A contacts the tip of the plug and lug B contacts the sleeve, thus providing a path for the battery's "−" end to ground through lug B. Just make sure to unplug the input cord after you've finished playing, for longest battery life. IC1B amplifies and buffers your signal. This signal goes to two places: the output mixer (IC1C), which combines this straight signal with the divided sounds, and to IC1A, which amplifies your signal a bit more to provide the best match for the compressor built around IC2A.

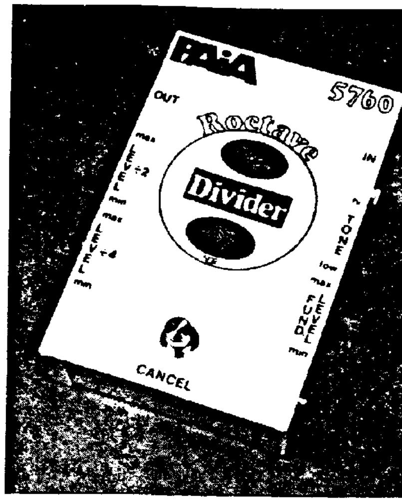
IC2A is half of a 571 or 570 compander chip. It's set up so that C4 provides lots of low-pass filtering, which emphasizes the fundamental and reduces the harmonic content in order to minimize "octave skipping" and other tracking problems. Using both filtering and compression produces a smooth, consistent signal which is easier to divide than a straight guitar signal.

OCTAVE DIVIDER

After being conditioned, the guitar signal hits IC1D. This is a comparator with a self-adjusting threshold; the self-adjusting feature means that you get maximum possible sustain out of this stage. IC1D then feeds two transistors. The transistor labeled Q1 produces a square wave whose frequency equals that of the note you're playing on the guitar. Resistor R4 taps this square wave, and sends it to expander IC2B before going to the output mixer. Q2 acts in a similar fashion to Q1. It conditions the signal coming out of IC1D and drives the actual octave dividers, IC3B and IC3A.

IC3 is a CMOS dual flip-flop, where both stages are set up to divide by two. Thus, IC3B's output (tapped by R5) is a square wave with a frequency one octave below that of your guitar's signal, and IC3A's output (tapped by R6) is a square wave two octaves below your guitar's signal. These two outputs, along with the output tapped by R4, mix together through R12, R13, and R14 and feed IC2B.

IC2B is set up as an expander, but we've done something a little unusual here. By tying pin 16 to pin 1, the dynamics of this stage follow the dynamics of IC2A, which in turn follows the dynamics of your guitar's note. Diode D1 reduces the voltage going to IC2B somewhat, which is why the divided note always decays just a little bit before your straight signal. IC2B's output feeds tone control R7, which connects to the output mixer IC1C via pin 9. In the meantime, the straight signal goes into IC1C via pin 8. IC1C's output couples through capacitor C7 to J2, the output jack.



A Few Fine Points

Note that all points marked with a circled "+" connect together; these combine to act as the 9V supply point. The Roctave Divider also requires a 4.5V supply; the necessary voltage is provided by the voltage divider made up of R15 and R16. The junction of these two parts is labeled "V" in a circle. This point connects to R24 (this is just below IC1B on the schematic).

S1 is the bypass switch. With S1 open, the octave divider works normally, with the straight signal and divided signals appearing at IC1C's output. With S1 closed, IC1A essentially "turns off," thus leaving only the straight signal present at the output. Simple, yes, but it works and it provides a noiseless switching action.

Finding Parts

All parts are pretty common, with the possible exception of the 570 and 4136. These are available from most mail order houses which advertise in the back of magazines such as *Polyphony* or *Radio-Electronics*, including PGS Electronics [Route 25, Box 304, Terre Haute, IN 47802]. A complete kit of parts is available from PAIA Electronics [1020 W. Wilshire Blvd., Oklahoma City, OK 73116]. It includes a screened and drilled case, circuit board, footswitch, components, sockets, etc. A Roctave Divider demo tape (10 minutes long, with 20 mono and 3 stereo examples I recorded using various instruments) is also available from PAIA. Refer to the parts list for pricing on these items.

Construction Tips

All the standard cautions apply: Observe the polarity of electrolytic capacitors and want this, change R17 to 39k.

+15V operation. Change R19 to 68k, and increase R12 through R14 to about 22k.

Greater overall output. Increase R18.

Jazz tone only. If you're not much into rock and roll fuzz sounds, change C6 to 1μF.

Stereo processing. Fig. 2 shows how to

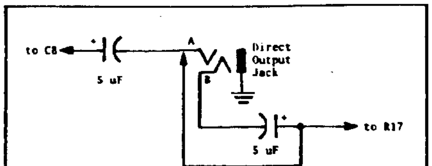


Fig. 2

insert three additional components (stereo closed-circuit 1/4" jack and two 5μF electrolytic capacitors) between C8 and R17 to add a direct output to the Roctave Divider. This output carries the straight sound; the divided and fuzzed sounds, less any straight sound, appear at J2. You may pan this output and the direct output to opposite ends of the stereo field, plug them into two channels of a two-channel amp, or add processing to the divided sound present at J2 without affecting the straight signal.

Conclusion. Many of you have written and asked for an octave box schematic, and at long last, here it is. Just remember to pick cleanly and practice; if you do, I think you'll be as delighted with this box as I am.

Roctave Divider Parts List

Resistors (all 10%, 1/4 watt unless noted)

R1	100 Ohms
R2	1k
R3	4.7k (4k7 metric)
R4	5k pot (fuzz control)
R5	5k pot (divide by 2 control)
R6	5k pot (divide by 4 control)
R7	5k pot (tone control)
R8-R16	10k
R17, R18	22k
R19-R21	30k (5%)
R22, R23	47k
R24, R25	100k
R26	270k
R27	470k
R28	680k
R29, R30	1M
R31	2.2M

Capacitors (16 or greater working voltage)

C1	330pF poly
C2, C3	0.1μF disc or mylar (100 nF metric)
C4	0.1μF mylar (100 nF metric)
C5, C6	0.22μF mylar (220 nF metric)
C7, C8	1.0μF electrolytic
C9-C11	2.2μF electrolytic
C12	4.7μF electrolytic
C13, C14	10μF electrolytic
C15, C16	100μF electrolytic

Semiconductors

D1	1N914 or equivalent diode
D2	1N4001 or equivalent diode
IC1	4136 quad op-amp
IC2	NE571 or 570 compander
IC3	4013 dual flip-flop
Q1, Q2	2N3906 PNP transistor

Mechanical Parts

J1	Stereo open-circuit 1/4" phone jack
J2	Mono open-circuit 1/4" phone jack
S1	SPST push-on/push-off footswitch
Misc.	Case, circuit board, knobs, wire, solder, etc.

The following are available from PAIA Electronics [1020 W. Wilshire Blvd., Oklahoma City, OK 73116]: Complete parts kit (stock number 5760), $39.95 plus $2.50 shipping/handling. Rocktave Divider demo cassette, $5.00 postpaid.

diodes (*very* important), use sockets for all ICs, heat-sink the transistor leads (hold them with a pliers or alligator clips) when soldering to minimize the possibility of heat damage, and make sure you use a fresh battery when you test the thing out. Also, IC3 is a CMOS IC, which may be destroyed by static electricity discharges. Keep this part in its conductive foam or foil until construction is complete, then, holding the circuit board ground with one hand, use your other hand to pop the IC into its socket.

The Roctave Divider is not a difficult circuit to build, but if you're unfamiliar with basic electronic construction techniques, make sure you look over the first five chapters of my book *Electronic Projects For Musicians* [Music Sales Corp., 33 W. 60th St., New York, NY 10023] before beginning. It should answer any questions you may have about identifying parts, soldering techniques, and so on.

Using The Roctave Divider

Patch your instrument into J1, patch J2 to your amp, and you should be ready to kick into action. Select the bass (rhythm, or neck) pickup for best results, and pick cleanly – if more than one string is vibrating at a time, the sound will be inconsistent. In most cases, you may leave the tone control at the full treble position, but if you have octave skipping around the middle of the neck to familiarize yourself with the way the box tracks your notes, and experiment with the various controls. Remember to pick more softly as you hit the lower end of the neck. Don't expect instant perfection, since octave dividers require *practice* for best results. I would think, though, that after about half an hour you should have the box pretty well figured out.

For a *fuzz-with-dynamics* sound, turn the tone control clockwise (full treble), turn up R4, and turn down R5 and R6. This sound resembles that of the Ultra-Fuzz (project #6 in *Electronic Projects for Musicians*), but with added dynamics. For a Wes Montgomery-type sound, turn the tone control all the way back for the bassiest sound, turn up R5, and turn down R4 and R6. Thanks to the dynamics and muted sound, the tone is quite warm and natural – not at all electronic-sounding.

For a thick, monster rock lead sound, turn up the tone control, turn up R4, and turn up R5 and R6 to suit your taste. You'll be amazed at the fullness of the sound. Hint: Adding a little equalization or chorusing will make the sound even bigger. One caution: If you turn up R4, R5, and R6 close to their maximum levels, the signals going through them might overload IC2B. This will make the dynamics circuitry behave improperly, and may produce ugly, distorted sounds. Should these problems occur, trim back a bit

Customization

There are numerous changes you can make to the Roctave Divider. First, we'll discuss those which relate to playing style. The Roctave Divider is intended to be compatible with the vast majority of guitars and playing styles. However, there are always those players with a very soft touch (or those who have guitars with weak pickups), and those who hit their strings as if they were mortal enemies. The symptoms of too soft a touch are inadequately divided signal level and poor sustain. If you experience these problems, increase C5 to 1μF and decrease R22 to 22k. If that doesn't make enough of a difference, try 10k.

If you play too hard, chances are the tracking will be erratic, and the dynamics circuitry will not work correctly (and you could get "sputtering" on the ends of notes as well). The cure is simple: Increase the value of R22 to 100k, 150k, or – if you have plutonium pickups and a bionic hand – maybe even 220k will be necessary.

Modifications

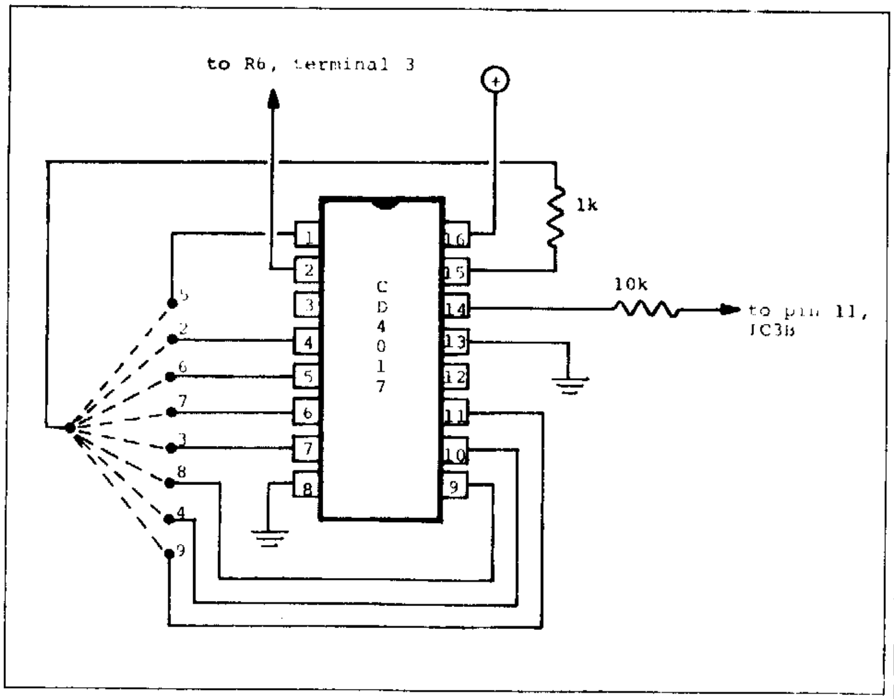
Here are some other possible modifications:

Unity gain (input level equal to output level) through the effect. This box is set up to give a bit of boost at the output. If you don't

CRAIG ANDERTON
ELECTRONIC GUITAR
Roctave Divider Modification

THE ROCTAVE DIVIDER has been an extremely popular and hassle-free project (see my feature in the Apr. '83 issue of *Guitar Player*). However, a few people have commented that they don't use the divide-by-four output much, and wondered if they could substitute some other feature instead. So, this month we'll cover a modification that lets you divide the guitar signal by any number from two to eleven. Not all of these divisions are musically useful, as you can see from this list of the notes produced by the various divisors. Assume *E* as the input note:

Divisor	Resultant note
2:	*E* one octave below input *E*
3:	*A* an octave and a fifth below
4:	*E* two octaves below
5:	*C* two octaves and a third below
6:	*A* two octaves and a fifth below
7:	Between *F#* and *G* close to two octaves and a seventh below
8:	*E* three octaves below
9:	*D* three octaves and a whole-step below
10:	*C* three octaves and a third below
11:	Between *A#* and *B* close to three octaves and a tritone below



Of these, divisors two through six are the most useful musically. However, for special effects the other outputs have their uses as well.

How it works. The schematic shows the complete mod (pretty simple, eh?). The CD4017 is a *decade counter/divider*, which can divide an input square wave by two through eleven, depending on which pin connects to the *reset* input (pin 15). For example, jumpering (connecting) pin 1 to pin 15 gives divide-by-five, jumpering pin 4 to pin 15 gives divide-by-two, pin 5 to pin 15 gives divide-by-six, and so on, according to the divisor numbers given on the left-hand side of the schematic. I would suggest using a rotary switch to select between the divisors you want to use. As one example, with a five-position switch you can select between divide-by three, four, five, six, and nine.

The modification. Use a 16-pin socket for the 4107, and make all connections to this socket. For best results, wire the socket and two resistors to a piece of perfboard or circuit board, make the connections listed below to the Roctave Divider circuit board, and insulate the mod circuit board with tape so that it doesn't short-out to the other circuitry. Remember too that the 4017 is a CMOS integrated circuit, and can be destroyed by static electricity discharges. Keep this part in its conductive foam or foil until construction is complete—then, holding the circuit board ground with one hand, use your other hand to pop the IC into its socket.

If you don't want to drill any additional holes in the case, simply jumper pin 15 to 7. This provides the divide-by-three function, which is probably the most musically valid option. Otherwise, wire up a switch to connect pin 15 to the desired divisor pins. For example, with an SPDT switch you might want to choose between divide-by-three (pin 7) and divide-by-four (pin 10).

Connect a wire to pin 11 of IC3B (note that if you used the recommended circuit board layout, there is a wire jumper next to pin 11 to which you can solder this lead), and connect the other end of this wire through a 10k resistor to pin 14 of the 4107. Next, disconnect the lead going from terminal F on the circuit board to terminal 3 or R6. This disables the stock divide-by-four output. Now connect a wire from pin 2 of the 4017 to terminal 3 of R6. This lets R6 control the level of the divided signal coming from the 4017.

Finally, connect the 4017's two ground connections to the Roctave Divider ground, and connect pin 16 from the 4017 to the Roctave Divider's positive supply (this is present at the jumpers running along the sides of IC1 and IC2 containing pins 8 through 14.

Testing. This is the fun part. Turn up R6, and you'll hear your new divided sound. With divide-by-three, the effect resembles the parallel harmony effects you'd get with a guitar synthesizer, and this can really thicken up your sound. Check it out!

Bonus mod. Here's another mod that is extremely easy, yet produces some wild timbres. The tradeoff is that the dynamics don't track as well (causing more noise at the end of notes), but this effect is so nasty you won't care about any residual noise. Simply connect a 0.1µF cap between pin 16 and pin 2 or IC2. This super-distorts the compander chip to give brassy, fat, buzzsaw sounds.

Final comments. I just *know* some people are going to write in and say they want divisors other than the ones listed above. However, these are the ones that are easiest to generate: trying to do anything more, like synthesizing specific notes, becomes horrendously complex. I'm also sure that some people are going to write and ask about generating notes that are higher instead of lower. Well, no promises, but I've been working on octave-above circuits for a while and am getting close to a breakthrough—so hang in there.

In the meantime, have fun with these mods, and we'll meet again next month.