Quadrafuzz

Model 6720k

Assembly and Using Instructions

Quadrafuzz[tm]

The following instructions include material by Craig Anderton previously published in the June 1983 issue of Guitar Player, along with supplemental material. This kit is designed for those with some experience in building electronic devices. Upon looking over the "Quadrafuzz", if it appears that this kit is beyond your particular level of expertise you may return the unassembled kit to PAIA for a refund of the kit price.

Once you successfully complete the kit, you will find that the Quadrafuzz is quite a fuzz: It sounds great, includes lots of extras, and features some novel design tricks which give it a unique sonic character. Best of all, the Quadrafuzz allows for a wide variety of different fuzz sounds--from smooth, liquid leads to chunky power chords that crash through a rhythm track. This is one fuzz which doesn't really have either a 'transistor' or 'tube' sound, but rather, seems to combine elements of the two and throw in its own personality on top of that.

Why are four fuzzes better than one? Before building the kit, it helps to understand what makes the Quadrafuzz different from other fuzzes. The major difference is that the Quadrafuzz splits the guitar signal into four separate frequency bands (low, mid 1, mid 2, and high), fuzzes each band individually, and then sums the four bands back together again to create a composite sound. (For More background on the Quadrafuzz, refer to my June 1983 Guitar Player column on "Fuzz and Filter Fun".) This multiple fuzz approach offers several benefits. First, chords and clusters of notes sound cleaner since there is less intermodulation distortion (i.e. 'harsh' distortion) compared to a single-channel fuzz. Second, the filters can be carefully tuned so as to increase certain desirable characteristics of the overall guitar sound. Third, boosting individual frequency bands helps increase the sustain at those parts of the audio spectrum. Adding these benefits together results in a sound that is cleaner than a conventional fuzz, and also includes more 'character' due to the peaking action of the filters.

Of course, the Quadrafuzz comprises far more than just the fuzz circuitry--it includes individual level controls for each channel, hi/lo filter resonance switches, tapped audio outputs for spreading the fuzz sound into stereo (or quad), a two-pole active low pass filter for precise overall sound shaping, effects loop for optionally adding other types of equalizers, CMOS electronic footswitching with LED status indicator, low or line level operation, and consistent operation with dc supply voltages ranging anywhere from +and- 8 to 20V DC, or, an ac transformer and rectifier diodes.

Construction

The Quadrafuzz is a high-gain, low-level, high input impedance device...just the right circumstances to produce a growling mass of feedback and hum unless you wire things up carefully. Since this is a relatively complex circuit, be patient. You must use rosin core solder and a low wattage (no more than 40 Watt), fine tip soldering iron. Work slowly and carefully: Pay particular attention to the IC pin numbers, diode orientation, and orientation of the electrolytic capacitors. Also remember that neatness counts--a neater circuit will often work more reliably than a circuit which is just thrown together.

Before continuing, check the parts included with your kit against the parts list in order to familiarize yourself with the various components. Assemble the kit in the following order:

1. Begin assembly by locating the eight jumper wire positions as designated by straight lines between holes on the printed circuit board. Using the solid, bare wire provided, measure each jumper to extend about 1/4" beyond each end and clip. Bend the ends to right angles, install and solder each jumper in place. Clip the excess lead at the top of the joint.

2. Starting with R1, mount and solder the resistors as indicated on the circuit board component legend.

3. Mount and solder the various capacitors, paying careful attention to the polarity of the electrolytic capacitors. Install Cs 34 and 35 at the same time so they fit the space.

4. Solder the four pairs of LEDs (D1/D2, D3/D4, D5/D6, and D7/D8) to the board. Note that each LED has a small flat spot, dot, or short leg to indicate the cathode. The polarity of the LEDs is crucial to obtaining a good sound, so double-check before soldering. Also remember that LEDs are sensitive to heat; it's best to solder quickly and efficiently in order to prevent accidental burnout.

5. Solder transistor Q1 into place. Like the LEDs, this part is heat-sensitive. Also solder diodes D10, D11, and D12 in place with the band aligned with polarizing graphic.

6. Solder regulators IC5 and IC6 into place. Note the markings on the regulators--one is positive and the other is negative. Also note the orientation graphic.

7. Mount the switches, potentiometers, and jacks on the front panel according to the illustration supplement. Carefully note the orientation of these parts. 'Hot Glue' the D9 Status LED to its hole in the panel. Use longer bolts, spacers, L-brackets (L down) and nuts for the lower holes on S1 and S4. The board will mount to these L-brackets

8. Front Panel Point-Point wiring. (sX) denotes solder X wires now. (ns) denotes No Solder yet.

Solder one end of the length of bare solid wire to J1-S (s1).

Route the wire up, down, and across to the left through each of the panel connector sleeve terminals and over to R52-3 and clip the length to connect and end at this point. Solder the wire to each sleeve (S) terminal but do not solder R52-3 yet.

Use 1" lengths of bare solid wire and make the following links:

R52-1 (s1) to R52-2 (ns).
R46A-1 (s1) to R46A-2 (ns). *section A is next to panel*
R46B-1 (s1) to R46B-2 (ns).

Cut each end of the red-red-red-gold 2200ohm resistor R4 to a length of 1/2" and use this resistor to link R46A-3 (s1) to R46B-2 (ns).

Measure, strip 1/4" from each end, twist, tin, and connect insulated stranded wire as follows:

4-1/2"	R52-3 (ns)	to	R17-1 (ns).
3-1/2"	R17-1 (s2)	to	R16-1 (ns).
3-1/2"	R16-1 (s2)	to	R15-1 (ns).
3-1/4"	R15-1 (s2)	to	R14-1 (ns).
3"	R14-1(s2)	to	R18-1 (s1).
4-1/4"	S2-2 (s1)	to	S3-2 (ns).
4-1/4"	S4-2 (s1)	to	S3-2 (ns).
12-3/4"	R14-3 (s1)	to	J6-T (ns).
11-3/4"	R15-3 (s1)	to	J7-T (ns).
7-3/4"	R16-3 (s1)	to	J8-T (ns).
7-1/2"	R17-3 (s1)	to	J9-T (ns).
15-1/2"	R46A-2 (s2)	to	J10-X (s1).
17"	R18-3 (s1)	to	J11-T (s1).
3"	J4-T (s1)	to	J5-T (ns).

Attach the circuit board to the panel using screws into the L-bracket threads .

Measure, strip 1/4" from each end, twist, tin, and solder insulated-stranded wire to printed circuit board points and connect or solder with front panel wiring points as follows:

A	16-3/4"	to	J1-T (s1).
B	15-3/4"	to	J1-R (s1).
C	15-1/2"	to	J2-T (s1).
D	5"	to	R52-2 (s2).
E	8"	to	D9 anode, non-flat, long-leg (s1).
F	9-1/4"	to	J3-T (s1).

G Used for optional transformer in later step.

H 8"	to	S5-3 (s1).
I 2"	to	R15-2 (s1).
J 8-1/2"	to	J9-T (s2).
K 6-3/4"	to	J8-T (s2).
L 9"	to	J7-T (s2).
M 8"	to	J6-T (s2).
N 3-3/4"	to	R14-2 (s1).
O 15"	to	J5-T (s2).
P 3-1/4"	to	R16-2 (s1).
Q 5-1/2"	to	R17-2 (s1).
R 8"	to	S5-2 (s1).
S 12-3/3"	to	J10-T (s1).
T 5-1/2"	to	S2-1 (s1).
U 11-3/4"	to	J11-X (s1).
V 8"	to	R18-2 (s1).
W 3-3/4"	to	S3-1 (s1).
X 6"	to	S4-1 (s1).
Y 6"	to	R46B-2 (s3).
Z 6-1/2"	to	R46B-3 (s1).
AA 8"	to	S1-2 (s1).
AB 7-1/4"	to	S1-3 (s1).

AC Used for optional transformer in later step.

AD 8-1/4"	to	LED D9 cathode, flat, short-leg (s1).
AE 6-1/2"	to	S3-2 (s3).
SG 8"	to	R52-3 (s3).

9. Insert and solder the ICs noting their polarizing marks vs. the designation graphics. Take care with IC4 as it is a CMOS IC and is susceptible to damage by static electricity.

10. Power to the unit is from an external DC power supply or batteries, or, an external ac transformer. The PAiA 9770U and a 9790 Power Connector kit combo can be used at the pc graphic outline. A bipolar or dual dc power supply (preferably regulated) in the range of +5 to +20 volts, or two batteries, can wire to these points. Use separate wires for the G and SG points to the dc supply ground (0V) point.

A 12v ac / 500mA wall mount transformer can substitute for a dc power source when connected at wiring points G and AC with diodes D10 and D11 in place. A jumper wire must be installed to link the DC supply points G and SG when an ac transformer is used.

11. Double-check all wiring carefully. Dress the wires as best you can to keep leads carrying low-level audio away from each other; however, don't worry about this too much for now, chances are things will work out all right. If hum or feedback problems crop up during testing, then you can get more seriously into checking over any lead layout problems.

Testing the Quadrafuzz

Because the Quadrafuzz includes a fair amount of circuitry, it's possible for the thing to appear to be functioning even if, say, two of the filter sections are defective. Of course, the sound will be nowhere near as good under these conditions, so plan to spend some time testing the unit to make sure all is well before you get too involved in playing.

Plug your axe into J2 (LO IN), and patch either J4 or J5 (Out) to your amp or monitoring system. Set the LO/LINE switch to match your amplifier's needs. With your amp turned down, turn on the power supply. If you see smoke or things smell 'warm', immediately shut down power and check your work against the schematic. After about 15 seconds, put your finger on top of each IC and check for heat. If any IC is running hot, again shut down power and check your work against the schematic.

The Quadrafuzz powers up in the bypassed position, so once you turn up your amp you should be hearing your straight guitar signal. Varying the controls should not affect this straight sound.

Now turn R14-R17 and R52 up halfway, R46 up 3/4s, R18 up about 1/2 of the way, make sure S1 is closed (BP position), and check that S2-S4 are open (low resonance position). Next, plug a footswitch (or 1/4" phone plug with its tip and ground shorted together) into J3. If LED D9 is lit, great; otherwise, press the footswitch and LED D9 should illuminate. As long as D9 is lit and you are playing your instrument, you should start hearing some fuzz effects. Adjust R18 for a good balance between the fuzzed and bypassed sounds.

To check whether the filter and fuzz sections are working more or less properly, kick the ATTACK clockwise for maximum fuzz (but below a setting so high as to get oscillation), play a power chord, and look at LEDs D1-D8. These should be glowing very faintly as you play (turn down room lights to check). If not, there's a problem. It could be a burned out LED, bad connection, or whatever--but trace down the source of the trouble before continuing.

Now test out the individual filters. Turn down R14-R17: There should be no sound coming from the Quadrafuzz. Next, turn each control up to get a feel for the different fuzz channel characteristics. The LO channel will sound boomier, while the HI channel will be thinner and more trebly. As you turn up each control, also flick the associated switch to observe the effects this makes on the sound. Each channel does not sound radically different from the other channels when listened to individually, but when combined, adding the channels together makes for some very interesting effects. This is particularly true with the HP/BP switch. When listening to the HI channel by itself, this switch appears to make very little difference. But when both the Lo and HI channels (and tone) are turned up, changing this switch can make a much more noticeable difference. Now vary the filter control and see how that changes the sound from bright to bassy. And if you want to experiment with the individual filter outputs, or patch another type of filter (like the PAIA 6760 Parametric Equalizer kit) into the effects loop to replace the Quadrafuzz low pass filter, be my guest.

Using the Quadrafuzz

A personal aside: After I had completed the final prototype and applied power, it didn't seem that the Quadrafuzz sounded as good as I had remembered it sounding. But within about fifteen minutes, I had re-discovered some of my favorite control settings and was getting the usual great sounds out of it. Moral of the story: It will take practice for you to learn this fuzz. Sure, the Quadrafuzz could have been designed as a preset device with a couple of killer sounds, but I instead opted for a fuzz with the greatest possible versatility. However, this requires that you learn the device well enough to focus on the neat sounds and avoid the duds. Speaking of neat sounds, for heavy metal type power chords kick the ATTACK up full, turn up the LO and Hi channels to max, and leave MID 1 and MID 2 down (although adding a bit of MID 1 sounds pretty good too). The filter setting is also critical; try trimming it back a tiny bit from full clockwise in order to keep the sound from getting to shrill. For those of you who are more into a Keith Richards chunky amp kind of sound, set ATTACK up about halfway, LO and HI fully counterclockwise, and MID 1 and MID 2 fully clockwise. Also try the high resonance position for one or both of the mid channels.

For lead sounds, there are many possibilites. Of course, patching a compressor in front of the Quadrafuzz itself is still quite good providing that the ATTACK control is up full. Experiment with the various controls, and try setting S1 to HP instead of BP from time to time.

For those of you who like a 'big' stereo sound and have access to a mixer, you can tap off the individual filter outputs via J6-J9 and send these outputs to four of the mixer channels. You may then add processing, EQ, or whatever tailors the sound in a way you find pleasing.

It cannot be emphasized enough that this is a fuzz which must be learned. Consider that there are four ways to control equalization when using the Quadrafuzz: via the ATTACK control (clockwise gives more highs), the individual filter channel and resonance controls, the low pass filter frequency control, and of course, the tone controls on your guitar itself. These all interact to a certain extent and can all greatly influence the final sound. Practice!

Troubleshooting

Here are some possible problems you might run into when de-bugging the Quadrafuzz, along with suggested solutions. High-pitched whistling sound: First, see if there could be a lead layout or shielding problem by pushing leads around. If separating certain leads solves or improves the problem, re-route the wires or use shielded cable instead. The problem could also be a control setting; compare the fuzzed and straight volume levels, and if necessary turn down R18 to bring them into better balance. Setting R18 too high tends to promote feedback problems.

Also try changing S1 from HP to BP, and turning down the ATTACK control if feedback problems persist.

Fuzzed sound is present even when unit is bypassed: Check that leads carrying high level fuzz sounds do not pass by input leads or input coupling capacitors. Re-route wires or push capacitors closer to the board.

Overly harsh distortion on one channel: One of the LEDs is probably either burned out from excess heat during soldering, or improperly oriented. I, along with all the folks at PAIA, hope that the Quadrafuzz kit goes together easily for you and that you find a valuable addition to your collection of effects. If you encounter any problems or have any questions, please call (405) 340-6300.

Design Analysis

While you don't have to understand the following theory behind the Quadrafuzz, the circuit demonstrates a lot of basic principles of musical electronics. So, try to get through the schematic shown in and pick up what you can; hopefully you'll find it interesting and educational.

IC1B is a preamp which accepts either a high level input (via J1) or a low level input (via J2). ATTACK control R52 sets IC1B's gain from 2 to 200. At higher ATTACK settings, this stage introduces some broadband distortion of its own that is particularly useful for lead sounds.

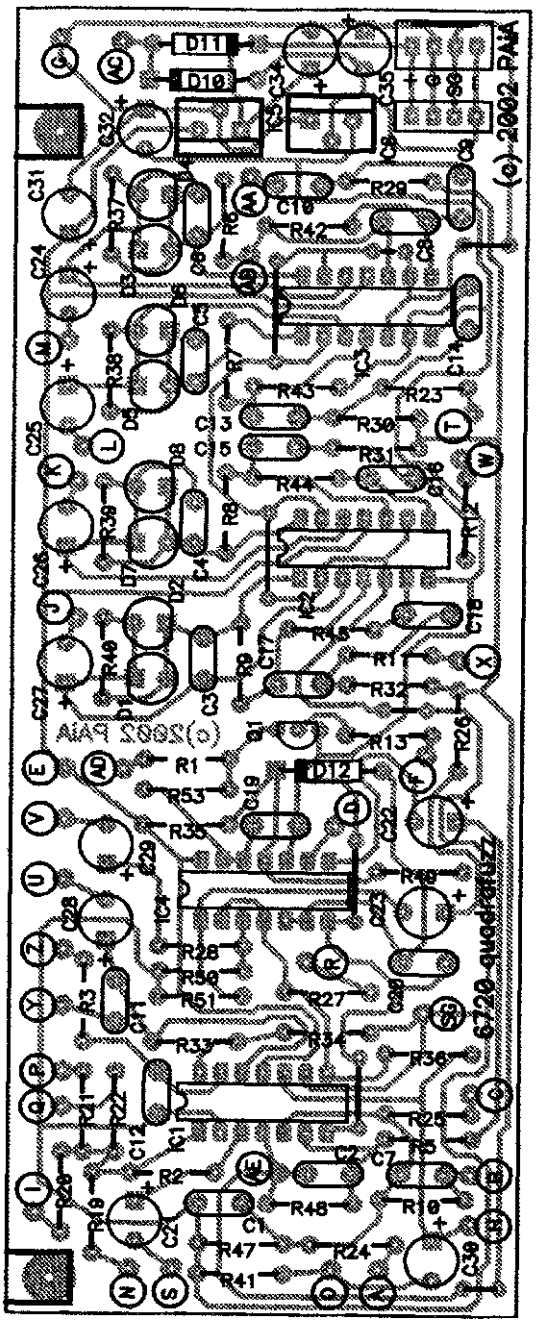
This preamped signal then splits (via R29 through R32) into four bandpass filters. The filter built around IC2B is the lowest, the one built around IC2C (MID 1) is tuned somewhat higher, and the filter built around IC3B (MID 2) is tuned approximately one octave higher than MID 1. The HI filter, IC3C, is tuned one octave higher than MID 2 but also offers a switch-selectable bandpass or pseudo-highpass response. The other filters include switches (S2-S4) which allow for increasing their resonance (sharpness).

The filter outputs then go to their own individual fuzzes, built around IC2A,IC2D,IC3A, and IC3D. These fuzz stages use LEDs rather than the usual diodes for the clipping (distortion-introducing) elements: I did so because LEDs clip at a high voltage, which allows for more output from each fuzz stage. LEDs also seem to clip in a somewhat gentler fashion than regular diodes, thus giving what is probably best described as a more 'rounded' sound.

Each filter output can be indivdually tapped (note that these outputs are in phase with the master output, so you won't run into cancellation problems if you use an external mixer to combine the individual outputs and master output together). Each filter output also feeds its own level control, so you can regulate the balance of the various frequency bands. The level controls go to a mixer (IC1A) which combines the signals together prior to feeding a tunable active filter (IC1D). This two-pole lowpass filter provides additional control over the final sound, and seems to work well with guitar. Also note that loop send jack J10 and loop receive jack J11 bypass the filter, thus letting you patch other types of filters or signal processors in place of the Quadrafuzz filter if desired.

The filter output proceeds to FUZZ LEVEL control R18, which feeds the output mixer/ electronic footswitch stage (IC1C and IC4A-D). The four schematic symbols that look like a cross between a pushbutton switch and a FET represent the individual FET switches inside a CMOS 4016 IC. These are arranged so that with the fuzz bypassed, FET switch IC4C is open (thus setting the preamp to minimum gain), and IC4A is closed (which alows the preamp output to feed into IC1C). When bypassed, IC4B is also open. With the fuzz effect active, IC4C closes to allow for adjustment of IC1B's gain, IC4A opens to cut off the straight signal, and IC4B closes to let through the fuzzed signal. D9, the status LED, is an integral part of the switching circuit. If for some reason you don't want to use an LED, then replace it with a 10K resistor.

IC5 and IC6 are regulators that provide a stable power source to the Quadrafuzz. They accept a bipolar supply voltage in the range of +and- 8to20V DC and regulate it down to +and- 5V DC. Diodes D10 and D11 rectify the ac voltage from a transformer to DC for input filter capacitors Cs 34 and 35 and the regulators.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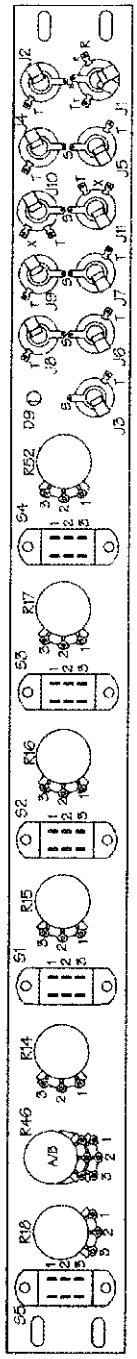
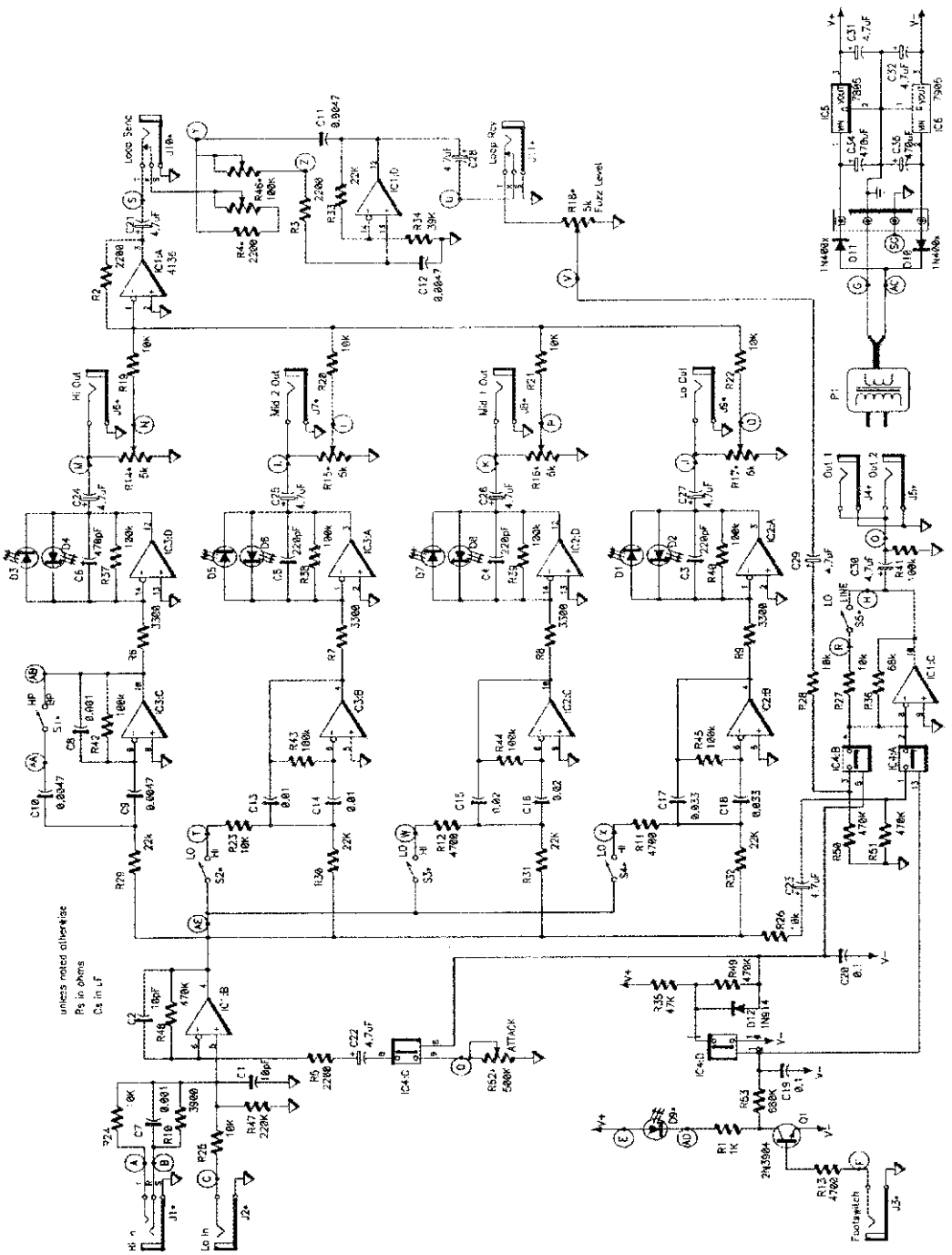
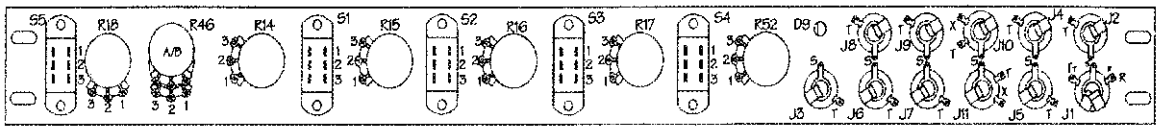
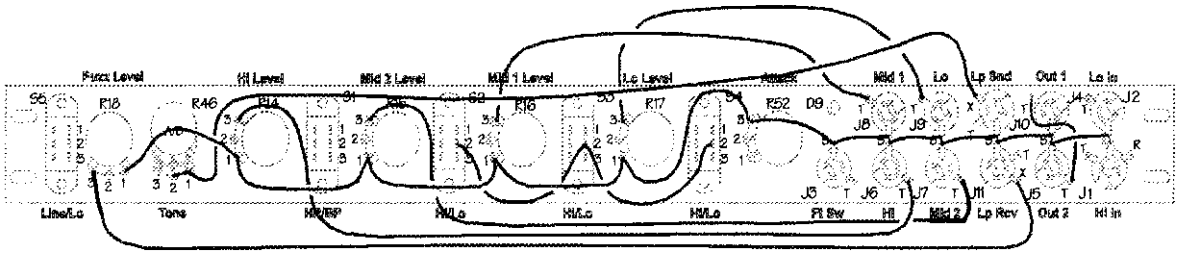
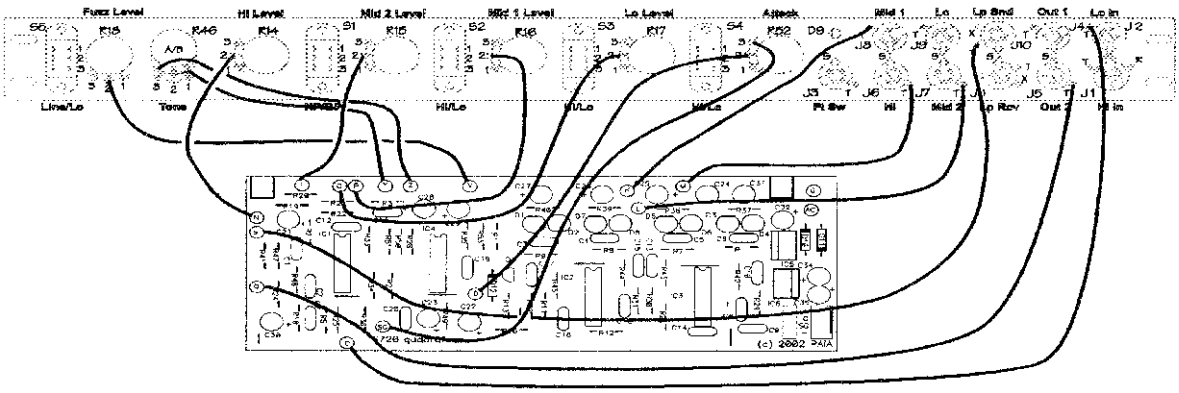
6720 quadrafuzz








Fuzz Level
Hi Level
Mid 2 Level
Mid 1 Level
Lo Level
Attack
Mid 1
Lo
Lp Snd
Out 1
Lo In
Line/Lo
Tone
HP/BP
Hi/Lo
Hi/Lo
Hi/Lo
Ft Sw
Hi
Mid 2
Lp Rcv
Out 2
Hi In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Hi
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Out 2
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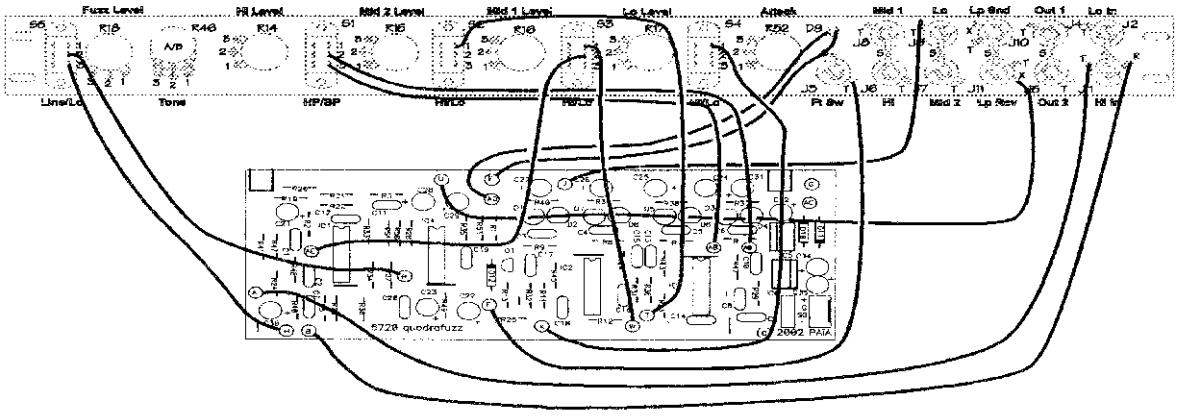
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Hi/Lo
Hi/Lo
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Hi
Mid 2
Lp Rcv
Out 2
Hi In
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Parts List

Quantity	Type	Value	Markings	Designation
Semiconductors				
1	4016 Quad Bilateral Switch			IC4
3	4136 Quad Op-amp			IC1, IC2, IC3
1	7805 +5v Regulator			IC5
1	7905 -5v Regulator			IC6
2	1N400x Rectifier Diode			D10, D11
1	1N914 or 1N4148 Signal Diode			D12
9	T1-3/4 Red LED			D1,D2,D3,D4,D5,D6,D7,D8,D9*
1	2N3904 NPN Transistor			Q1
Electrolytic Capacitors				
2	470uF/25v			C34, C35
12	4.7uF/10v			C21,C22,C23,C24,C25,C26 C27,C28,C29,C30,C31,C32
Ceramic Capacitors -- values in uF except as noted				
2	0.001		102	C7, C8
4	0.0047		472	C9,C10,C11,C12
2	0.01		103	C13, C14
2	0.022		223	C15, C16
2	0.033		333	C17, C18
2	0.1		104	C19, C20
2	10pF		10	C1, C2
3	220pF		221	C3,C4,C5
1	470pF		471	C6
Resistors -- values in ohms, 1/4w carbon film				
9	100k	brown-black-yellow-gold		R37,R38,R39,R40,R41,R42,R43, R44,R45
10	10k	brown-black-orange-gold		R19,R20,R21,R22,R23,R24,R25,R26, R27,R28
1	1k	brown-black-red-gold		R1
4	2200	red-red-red-gold		R2,R3,R4*,R5
1	220k	red-red-yellow-gold		R47
5	22k	red-red-orange-gold		R30,R31,R32,R33,R29
4	3300	orange-orange-red-gold		R6,R7,R8,R9
1	3900	orange-white-red-gold		R10
1	39k	orange-white-orange-gold		R34
3	4700	yellow-violet-red-gold		R11,R12,R13
4	470k	yellow-violet-yellow-gold		R48,R49,R50,R51
1	47k	yellow-violet-orange-gold		R35
1	680k	blue-grey-yellow-gold		R53
1	68k	blue-grey-orange-gold		R36
Panel Mount Potentiometers				
1	500k			R52*
5	5k			R14*,R15*,R16*,R17*,R18*
1	100k dual			R46*
Panel Mount 1/4" Phone Jacks				
8	o.c. (open circuit)			J2*,J3*,J4*,J5*,J6*,J7*,J8*,J9*
2	c.c. (closed circuit)			J10*, J11*
1	t.r.s (TipRingSleeve, stereo)			J1*
Misc.				
1	6720		Printed Circuit Board	
5	switches		DPDT Slide	S1*,S2*,S3*,S4*,S5*
1	12v ac 500ma		Transformer	P1*
7	set-screw		Knobs	
10	#4-40		Hex Nuts	
10	#4-40x1/4"		Machine Screws	
2	#4-40x1"		Machine Screws	
2	3/4"		Rolled Aluminum Spacer	
2	#4-40		L-Bracket	
1	360" length		Insulated Stranded wire (#22, multiple colors/pieces)	
1	20" length		Bare, plated solid wire (#22, jumper-wire)	

* = parts mounted off the printed circuit board