

OHMS LAW

OHMS LAW IS A FUNDAMENTAL PRINCIPLE IN ELECTRONICS. IT DEFINES THE RELATIONSHIP BETWEEN VOLTAGE (V), CURRENT (I), AND RESISTANCE (R).

CURRENT IS THE RATE OF FLOW OF ELECTRONS, MEASURED IN AMPS.

AMP = A

$$1 \text{ MILLIAMP} = 1 \text{ mA} = 0.001 \text{ A} = 1e^{-3}$$

$$1 \text{ MICROAMP} = 1 \mu\text{A} = 0.000001 \text{ A} = 1e^{-6}$$

RESISTANCE IS THE PROPERTY OPPOSING THE FLOW OF ELECTRONS, MEASURED IN OHMS.

OHM Ω = r

$$1 \text{ KILO OHM} = 1 \text{ k} = 1000 \text{ r} = 1e^3$$

$$1 \text{ MEGA OHM} = 1 \text{ M} = 1,000,000 \text{ r} = 1e^6$$

CURRENT AND RESISTANCE ARE RELATED BY ANOTHER PROPERTY VOLTAGE, WHICH MEASURES THE POTENTIAL DIFFERENCE BETWEEN TWO POINTS. THE DIFFERENCE IN POTENTIAL CAUSES CURRENT TO FLOW.

VOLT = V

$$1 \text{ MILLIVOLT} = 1 \text{ mV} = 0.001 \text{ V} = 1e^{-3}$$

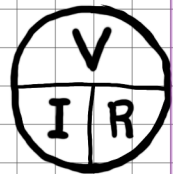
$$1 \text{ MICROVOLT} = 1 \mu\text{V} = 0.000001 \text{ V} = 1e^{-6}$$

OHMS LAW DEFINES THE RELATIONSHIP BETWEEN VOLTAGE, CURRENT, AND RESISTANCE.

$$V = I \times R$$

$$I = V / R$$

$$R = V / I$$

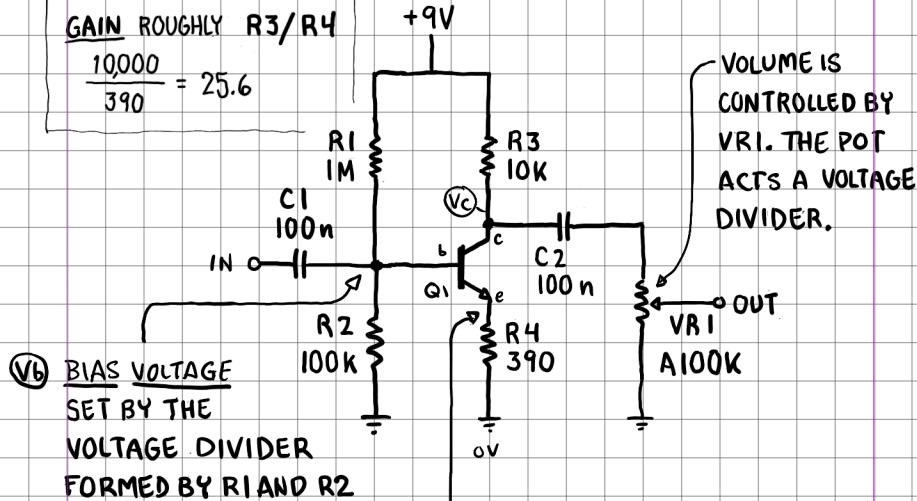


COMMON EMITTER AMPLIFIER

THE LPB-1 IS A BOOSTER/BUFFER MADE BY ELECTRO-HARMONY SINCE 1968. IT IS AN EXAMPLE OF A COMMON EMITTER AMPLIFIER, A COMMON BUILDING BLOCK FOUND IN MANY GUITAR PEDALS.

GAIN ROUGHLY $R3/R4$

$$\frac{10000}{390} = 25.6$$



VOLUME IS CONTROLLED BY VR1. THE POT ACTS A VOLTAGE DIVIDER.

V_b BIAS VOLTAGE SET BY THE VOLTAGE DIVIDER FORMED BY R1 AND R2

$$\frac{R2}{R1 + R2} \times 9V$$

$$\frac{100k}{1100k} \times 9V = 0.82V$$

V_e EMITTER VOLTAGE

$$V_e = 0.82V - 0.6V = 0.22V$$

I_e EMITTER CURRENT

$$I_e = V_e / R4 = 0.22V / 390 = 0.56mA$$

V_c COLLECTOR VOLTAGE

$$9V - (I_c \times R3)$$

$$9V - (0.56mA \times 10k) = 3.4V$$

HEADROOM

WITH NO CURRENT AT THE BASE OF Q1 THERE IS 9V AT THE COLLECTOR. WITH A HIGH CURRENT AT THE BASE Q1 IS FULLY ON AND ACTS AS A VERY LOW RESISTANCE BETWEEN C AND E. COLLECTOR VOLTAGE IS:

$$\frac{390}{10k + 390} = \frac{390}{10390} \times 9V = 0.34V$$

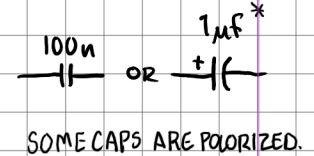
CAPACITORS

CAPACITORS BLOCK DC AND PASS AC SIGNALS. THEY ARE USED TO COUPLE AUDIO (AC) SIGNALS, AND FILTER AUDIO.

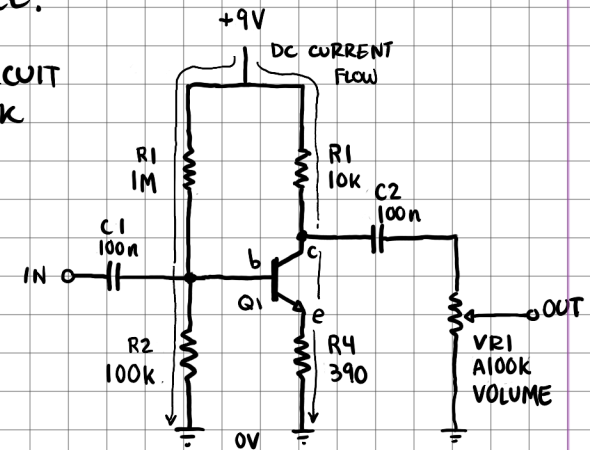
CAPACITORS HAVE A PROPERTY CALLED CAPACITANCE, MEASURED IN FARADS. A FARAD IS A VERY LARGE VALUE, VALUES COMMONLY ENCOUNTERED ARE MICRO FARADS, NANO FARADS, AND PICO FARADS.

1 FARAD	= F	
1 MILLI FARAD	= 1mF = 0.001F	= 1e-3
1 MICRO FARAD	= 1μF = 0.000001F	= 1e-6
1 NANO FARAD	= 1nF = 0.000000001F	= 1e-9
1 PICO FARAD	= 1pF = 0.000000000001F	= 1e-12

THE SYMBOL FOR CAPACITOR LOOKS LIKE TWO PARALLEL LINES. DC CURRENT CANNOT CROSS THE "GAP". THE AMOUNT OF AC A CAPACITOR PASSES DEPENDS ON FREQUENCY AND CAPACITANCE.

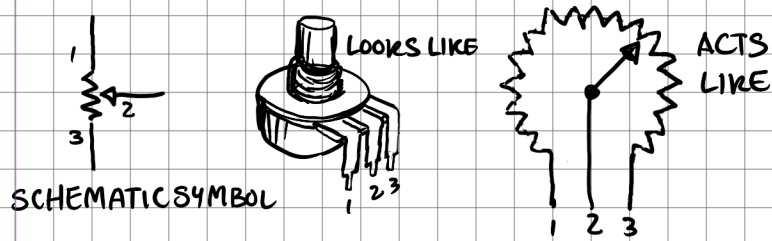


IN THE LPB-1 CIRCUIT C1 AND C2 BLOCK DC CURRENT.

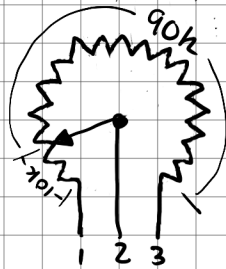
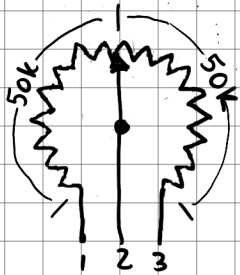
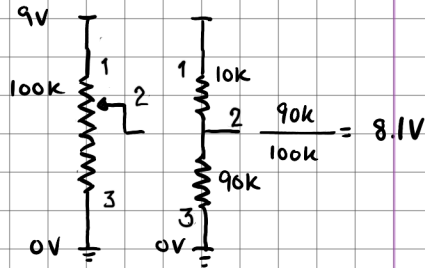
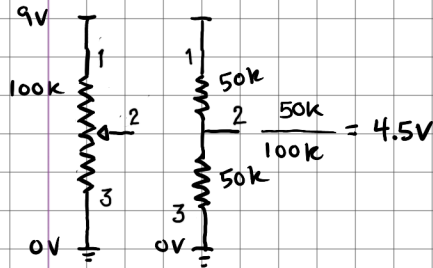


POTENTIOMETER

A POTENTIOMETER IS AN ADJUSTABLE RESISTOR DIVIDER. THESE HAVE THREE LEGS. THE SYMBOL LOOKS LIKE THIS.



POTS ARE USED AS ADJUSTABLE PARAMETERS. IMAGINE A 100K POT



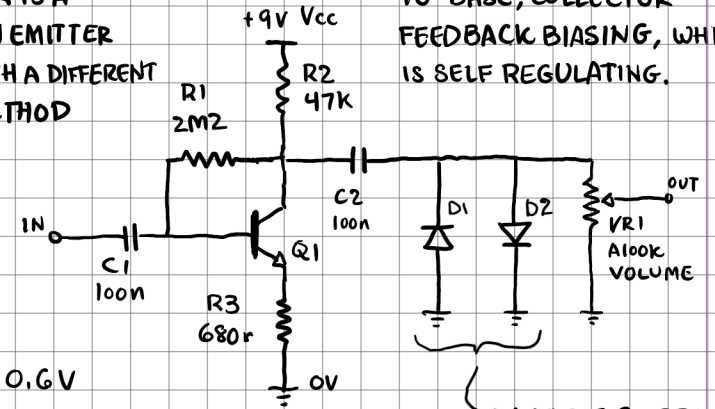
ELECTRA FUZZ

THIS IS A DISTORTION CIRCUIT FROM THE EARLY 1970s THAT HAS BEEN CLONED AND USED AS A BUILDING BLOCK IN MANY OTHER CIRCUITS.

THIS CIRCUIT USES DIODES TO CREATE DISTORTION. THE DIODES CLIP THE SIGNAL WHEN IT EXCEEDS THE DIODE'S FORWARD VOLTAGE.

ELECTRA IS A COMMON EMITTER AMP WITH A DIFFERENT BIAS METHOD

R1 CONNECTS COLLECTOR TO BASE, COLLECTOR FEEDBACK BIASING, WHICH IS SELF REGULATING.



$$V_{be} = 0.6V$$

$$I_c = \frac{(V_{cc} - V_{be})}{(R_c + R_e + R_b/h_{FE})}$$

$$= \frac{(9 - 0.6)}{(47k + 680r + 2.2M/200)}$$

$$= \frac{8.4}{(47680 + 11000)}$$

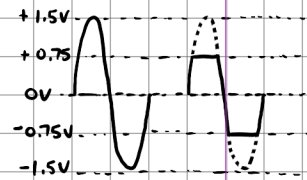
$$= 0.14mA$$

COLLECTOR VOLTAGE

$$V_c = 9V - (0.14mA \times 47k) = 2.4V$$

BASE VOLTAGE

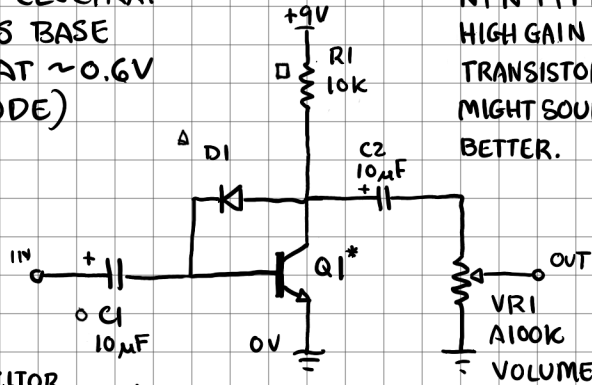
$$V_b = V_e + 0.6V = (0.14mA \times 680r) + 0.6V = 0.7V$$



BAZZ FUSS

A CIRCUIT FROM THE EARLY DIY COMMUNITY, BY CHRISTIAN NÉ HEMMO. IT HAS BEEN MODIFIED AND CLONED FOR DECADES.

COLLECTOR FEEDBACK BIAS
SIMILAR TO ELECTRA.
D1 CLAMPS BASE
VOLTAGE AT $\sim 0.6V$
(VF OF DIODE)

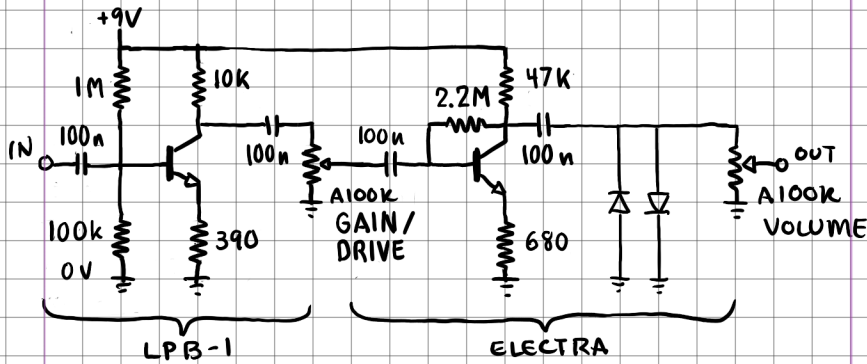


* Q1 CAN BE ANY
NPN TYPE.
HIGH GAIN
TRANSISTORS
MIGHT SOUND
BETTER.

○ INPUT CAPACITOR
C1 HAS A STRONG
EFFECT ON THE
SOUND. A SMALLER
VALUE WILL CUT
BASS.

△ DIODE D1 CAN BE ANY TYPE.
DIODES WITH DIFFERENT FORWARD
VOLTAGES WILL SOUND DIFFERENT.

□ ADJUST R1 TRY 10K - 100K.

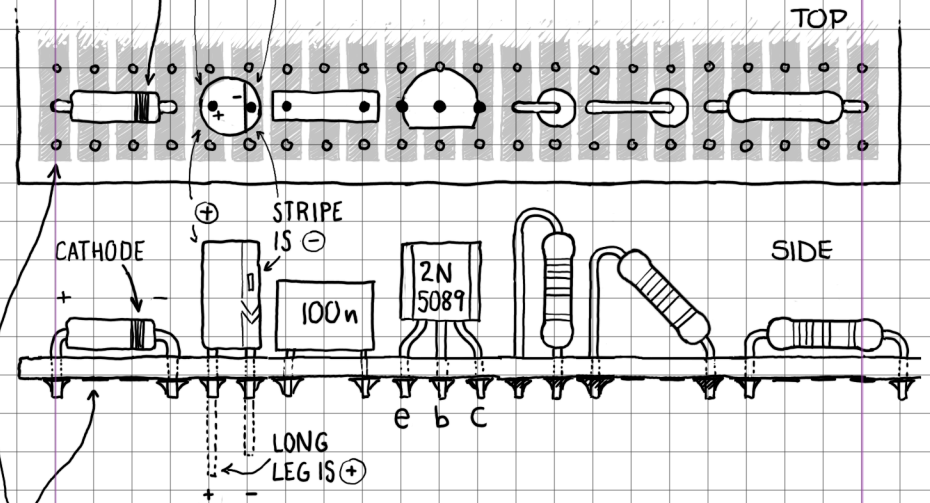


COMBINE CIRCUITS TOGETHER TO MAKE
SOMETHING NEW!

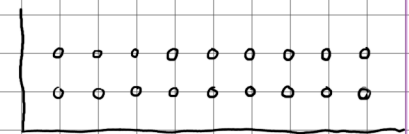
PROTOTYPING

BUILDING A CIRCUIT ON STRIPBOARD/VEROBOARD IS A GOOD SECOND STEP AFTER TESTING ON A SOLDERLESS BREADBOARD. STRIPBOARD IS PREDRILLED WITH COPPER STRIPS ON ONE SIDE. COMPONENTS ARE PLACED ON THE TOP AND SOLDERED TO THE COPPER ON THE BOTTOM. ALL OF THE LEADS SOLDERED THE SAME COPPER STRIP SHARE AN ELECTRICAL CONNECTION.

DIODE	CAPACITORS		TRANSISTOR	RESISTORS		
D1	C1	C2	Q1	R1	R2	R3
ANODE + CATHODE -	+	-	b e c	—	—	—
914 STRIPE	47µf	100n	2N5089	10K	47K	100K



COPPER STRIPS
ON THE BOTTOM
PARTS ON TOP



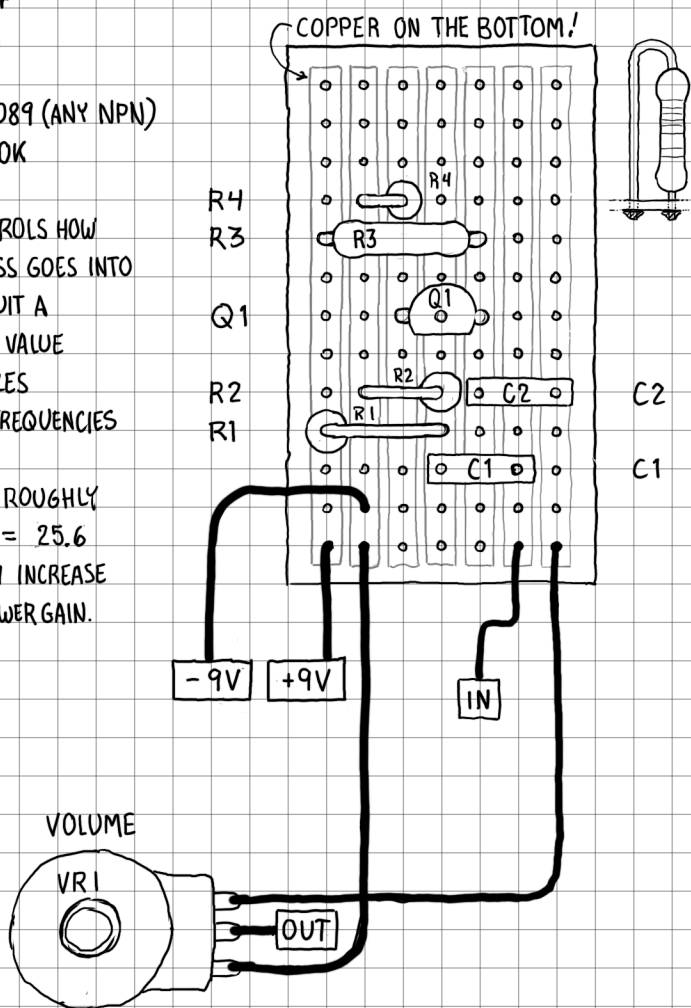
LPB-1 LAYOUT

LPB-1 IS A BOOSTER MADE BY ELECTRO HARMONIX. IT IS A COMMON EMITTER AMPLIFIER WHICH IS A BUILDING BLOCK USED IN MANY CIRCUITS.

- R1 1M
- R2 100K
- R3 10K
- R4 390r
- C1 100n
- C2 100n
- Q1 2N5089 (ANY NPN)
- VR1 100K

C1 CONTROLS HOW MUCH BASS GOES INTO THE CIRCUIT A SMALLER VALUE EMPHASIZES TREBLE FREQUENCIES

GAIN IS ROUGHLY $R3/R4 = 25.6$ YOU CAN INCREASE R4 TO LOWER GAIN.



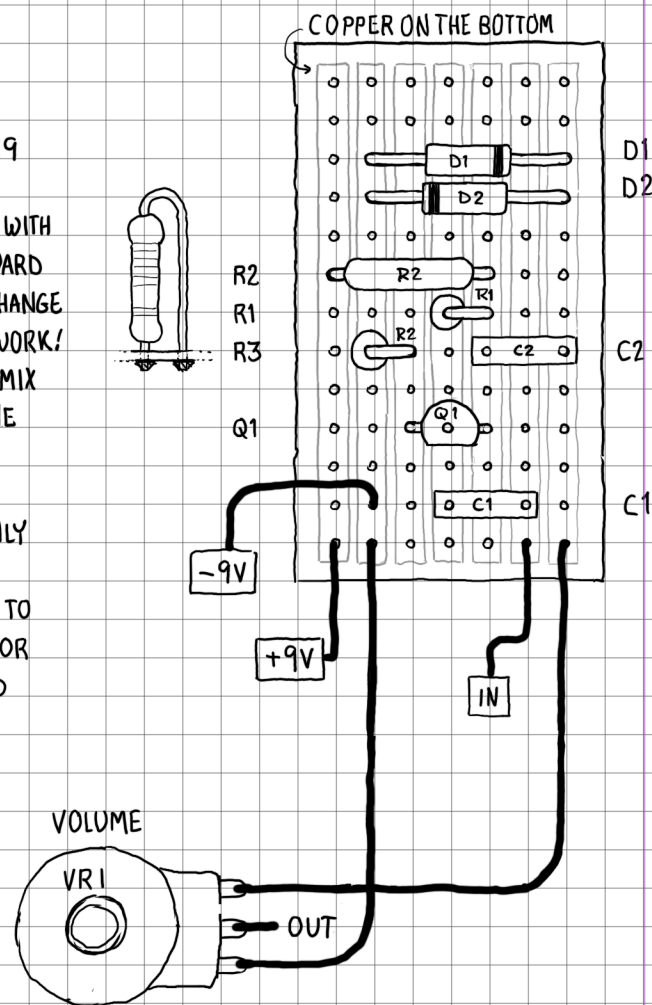
ELECTRA LAYOUT

ULTRA SIMPLE DISTORTION FROM THE 1970s. IT USES HARD CLIPPING LIKE THE BOSS DS-1, MXR DIST+, AND PRO CO RAT.

- R1 2M2
- R2 47K
- R3 680r
- C1 100n
- C2 100n
- D1 1N914
- D2 1N914
- Q1 2N5089

USING DIODES WITH DIFFERENT FORWARD VOLTAGE WILL CHANGE SOUND. LEDs WORK! YOU CAN ALSO MIX TYPES, COMBINE LED + 1N914.

GAIN IS ROUGHLY $R2/R3 = 69$ INCREASE R3 TO LOWER GAIN FOR LESS DISTORTED SOUND.



BAZZ FUSS LAYOUT

- R1 10K (TRY VALUES UP TO 100K)
- D1 1N914 (ANY DIODE, OR LED)
- Q1 2N5089 (ANY NPN, HIGH GAIN IS BETTER)
- C1 10 μ F (TRY ANY VALUE)
- C2 10 μ F 100n - 10 μ F)

ULTRA SIMPLE FUZZ BY
CHRISTIAN HOLMBERG (HEMMO)
THIS IS A DIY CLASSIC SINCE
THE EARLY 2000s!

COPPER ON THE BOTTOM!

