TEACHING
MACHINES

Fuzzbillion

NUMERICAL TONE SWITCHING

Operation Manual & Notebook

Many thanks for buying the FuzzBillion

The Fuzzbillion is a distortion device for guitar, bass and synthesizers. It can be used with 'guitar' or 'line-level' signals. The numerical switches provide the ability to shape the distortion in ways far beyond conventional distortion devices.

Effects ranging from subtle overdrive to screaming distortion can be achieved simply by changing the numbers.

The unit is completely analogue and uses multiple types of diodes and amplification devices from germanium to silicon and light-emitting diodes.

Changing the numbers changes the circuit itself, introducing different variations, some extreme, some subtle. The signal flow is from left to right so changes you make on the earlier numbers will affect what happens further down the signal path.

Total recall is possible, simply - write down the number (or photograph it) and you can return to your exact sound whenever you like. There is a section at the back of this manual for you to record your favourite settings.

You are about to embark on a long strange trip into a world of distortion fuzz and overdrive

Quick Start Guide

If you're scratching your head try following this simple guide to get you started.

Firstly, if using a guitar, set both guit/line switches on the sides of the pedal to guitar mode by pushing and clicking them in.

1 Set all the wheels to 0:
00000000000

This is a fairly clean sound, not the cleanest possible (that is 00559000000 for reasons which will be explained eventually).

This is a soft sound with a hint of distortion.
As wheels three and four are set to 0, there are germanium diodes clipping the positive and negative peaks of the signal.

The germanium diodes clip at a low voltage, so even with quiet sounds they are adding a little distortion.

2 Now increase the second wheel to 5:
05000000000

This increases the gain in the amplifier that the germanium diodes are around, and gives more distortion, but a similar sound. Try increasing the gain further.

3 Now increase the third wheel to 1:
05100000000

This changes the positive clipping to a silicon 1N60P diode, while keeping the negative on the same germanium setting.

You will hear the signal get louder, as silicon diodes allow a higher voltage before they start to conduct. Also the sound will get a little thicker and more distorted.

Having two different kinds of diodes makes the distortion asymmetric, as both sides of the waveform are being distorted in different ways.

4 Now increase the fourth wheel to 1:
05110000000

This makes the distortion a little louder again, and a little more even, as we now have the same silicon diodes clipping both sides of the waveform.

5 Try setting the third and fourth to 2 now:
05220000000

This brings in a different type of silicon diode, which have an even higher voltage, and the signal becomes louder and more distorted again.

6 Now set the third and fourth to 3:
05330000000

This brings in a pair of light emitting diodes (LEDS). These have an even higher voltage, and also a different sound to the previous ones. If you could see the circuit board, you would see them lighting up when you play a chord!

7 Lets combine an LED with a germanium diode:
05300000000

The distortion becomes quieter, and perhaps a little smoother sounding.

This is quite a nice sound, but we want a bit more drive.

8 So, lets turn up the gain around the diode clipping:
09300000000

This is now louder and more distorted again, but still the same kind of sound.

Another way of getting more drive is to turn up the first wheel. This acts a bit like putting a booster pedal before the diode clipping.

9 Try this:
35200000000

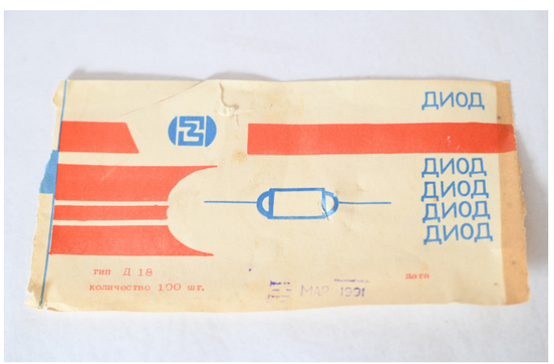
This brings in the opamp boost before the clipamp. It is a little thicker and rougher sounding compared to setting the second wheel to 9.

10 Let's try making this a little brighter sounding by setting wheel 5 (tone) to 3:
35303000000

This sounds brighter now, but maybe a little too much.

11 We could back the tone off again, or we could use the low pass filter that is wheel eleven:
35303000003

Now the sound is darker and smoother.



Some of the weird diodes we're using in the FuzzBillion

12 Lets add a bit of complexity and harshness to the distortion by introducing some output clipping, by setting wheel ten to 1:
35300000013

This is quite a subtle change, so try changing wheel ten between 1 and 0 a few times while playing chords to make it clearer.

It adds a bit more crunchy clipping to the sound, by putting a green and blue LED diode clipper to the output of the fuzzbillion. If you could see the circuit board these light up when you play!

13 Try changing wheel ten to 2 as well:
35300000023

This uses two red LEDs, and sounds similar, but as the clipping is symmetric will have subtle changes when used with other kinds of clipping earlier in the chain.

14 Try changing wheel ten to 9 now:
35300000093

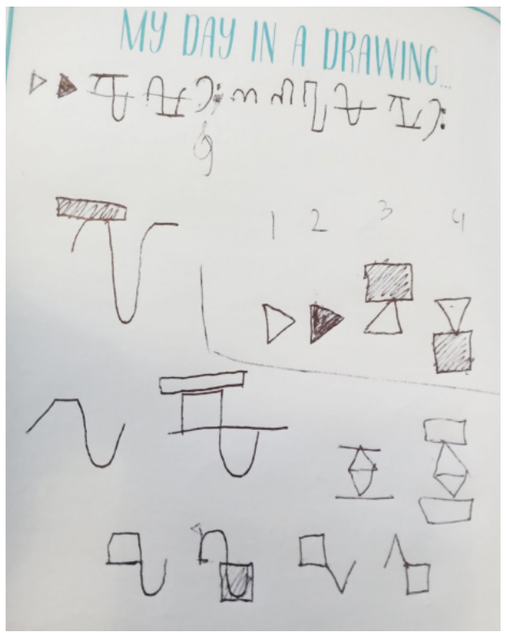
This changes the output clipper to two germanium diodes. These conduct at a much lower voltage than any other diode, so the overall output level will get much quieter. You will probably have to turn up the output volume control to compensate.

Also, as they are clipping more, the sound will be brighter and more aggressive.

15 Let's cut a bit more treble using wheel eleven to compensate:
35300000095

By setting wheel eleven to 5, we are cutting treble at a lower frequency, making the sound smoother.

The balance of getting the various stages and types of clipping working together can lead to some interesting sounds.



Frank's primitive scrawlings lol

Complete Guide

Here we take you through every single control and what's actually happening inside.

FOOTSWITCH

This enables or completely bypasses the distortion. A red light next to the gain knob comes on when the pedal is operational.

GAIN KNOB

This controls the output level of the pedal.

INPUT GUIT/LINE Switch

This is a push switch on the right side of the pedal that selects the input between a HI impedance UNBALANCED guitar type input (pushed in) and a LOW impedance BALANCED line input (out). An LED on the side of the case will illuminate to indicate LINE position.

When in line level, the input is wired tip=hot, ring=cold, barrel=shield.

The line input will work fine with unbalanced cables.
The line input is roughly 1K impedance, and is **transformer balanced.**

You *can* use the line mode with a guitar, where it will sound quieter and softer.

OUTPUT GUIT/LINE Switch

This is a push switch on the right side of the pedal that selects the output between a HI impedance UNBALANCED guitar type output (pushed in), and a LOW impedance BALANCED line output (out).

When in line level, the output is wired
tip=hot, ring=cold, barrel=shield.

The line output will work fine with unbalanced cables.
The line output is roughly 1K impedance, and is **transformer balanced.**

The line output stage and transformers are situated after the 'output level' pot, and as the output stage has gain, it can add yet more distortion and saturate output transformers when the output level is high. This is a good thing.

Try turning down the input gain on whatever device you have the line output plugged into, and increasing the output gain control on the fuzzbillion to hear this effect.

note:

You can combine different guit/line settings on both switches.

For example, for a Bass or Guitar to line level DI, try setting input to guit mode, output to line mode, and wheels to 00009000000 This will clean up when the output gain is reduced. (The 9 disables the tone, but you might prefer 0 in this application!)

Power Supply

The power supply should be centre negative, 9 volts, and able to provide at least 50ma of current.
The jack size is 2.1mm

A 'Boss standard' power supply will work perfectly.

Make sure to use a good quality clean power supply, a noisy power supply will create interference or hum.

The Power Input Socket is at the rear of the pedal.

Guitar/Line level Switches

The FuzzBillion offers you the best of all worlds.

Guitar level and (transformer balanced) Line level inputs *and* outputs are selectable in any configuration you want.

INPUT GUIT/LINE switch. The LED lights up when in LINE mode.

OUTPUT GUIT/LINE switch.

The Wheels
and their symbols

Wheel ONE: GAIN BOOST

Wheel one selects different kinds of boost amplifiers.

Setting 0 is bypass, and is the cleanest setting:
00000000000

Wheel settings 1–4 use an opamp to reduce or boost the gain. Opamps are quite clean and full sounding, so are a clean boost.

Setting 1 brings in an opamp boost, but also reduces its output gain, so it is quieter than setting 0
10000000000

Setting 2 is the same opamp boost, but with a bit more gain.
20000000000

Setting 3 is the same opamp, with yet more gain.
30000000000

Setting 4 is the same opamp, with even more gain
40000000000

Settings 5-8 use a single transistor boost. The transistor is misbiased, so is a bit dirty and gated sounding.
You will hear notes cut off, and quieter sounds are more distorted. Try turning the volume of your guitar down to hear this more obviously. 6, 7 and 8 are increasing output gain.
50000000000

This can be useful sometimes when combined with more gain from a following stage.

For example, this sound has a plucky 60s quality:
56019000006

Setting 9 is an even more extreme version of settings 5-8
It adds a second transistor in series, with even worse bias, and sounds quite nasty.
90000000000

This can drive the following stages quite hard, try this for size:
90550000000

Wheels TWO, THREE and FOUR: CLIPPING AMPLIFIERS

These wheels work together so we'll talk about them together!

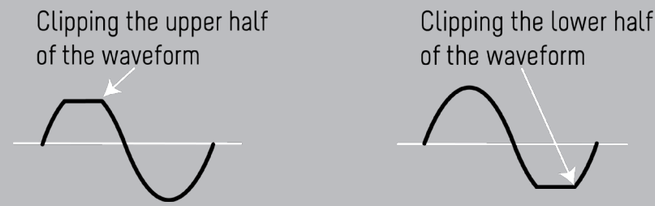
These control the gain around the main clipping amplifier and how it clips.

Wheel two increases the gain, and wheels three and four bring various different components into the amplifier's negative feedback path.

Wheel three controls negative clipping (the upper part of the waveform), and wheel four positive clipping (the lower part of the waveform).

The Components of Wheels THREE and FOUR

Changes to Wheel Three affect the top half of the waveform whilst changes to Wheel Four affect the lower half of the waveform.



Setting 0 Germanium diode. These conduct at a low voltage, with a smoother slope before conducting fully, and so the clipping is softer and quieter.

Setting 1 1N60P silicon diode. These conduct at a higher voltage, and have quite a sharp cut-off.
The clipping is louder and harsher.

Setting 2 1N4148. Higher voltage again, and sharper.

Setting 3 LED diodes. Harder more clipping, depending on gain.

Setting 4 This puts a capacitor in the feedback loop instead of a diode, which cuts the treble.

Wheels three and four are different here, with three having a smaller capacitor and less treble cut.
It can be interesting to combine a capacitor and diode together such as:
39430000000 which gives a compressed and 'breathing' distortion.

Setting 5 Nothing at all. In this mode all the clipping comes just from the opamp.

Settings 6 to 9 These are similar to setting 0-3, but with an extra resistor so the clipping voltage is raised even more.
This gives less clipping and more gain.

Wheel FIVE: TONE

This is a tone control.

Setting 0 is most bassy and 8 is most treble.

Setting 9 removes the EQ entirely. As it is a passive EQ, this also leads to a boost in level.

WheelS SIX and SEVEN

These control the octave fuzz.
An octave fuzz creates a sort of octave up sound, by inverting the lower half of the waveform.

Wheel Six controls the octave fuzz drive, and wheel seven controls how much of it is mixed in. Wheel six will only make an audible difference when wheel seven is set above 0.

Try this clean setting:
00550000000

Now mix in some octave fuzz:
00550050000

Add some more:
00550090000

And try some more drive:
00550990000

Wheel EIGHT: PLL

A PLL is a 'phase locked loop.' This is a bit like an oscillator that tries to play in tune with the input signal.

The different settings on the Wheel control how fast and how accurately it tracks the pitch. It is rather unpredictable and odd though, so mostly makes unusual noises.

It requires a fairly loud signal to make it work, so you might not hear anything (at all) if there isn't much gain and clipping going on before it.

Try this setting:
99449007045

Play single high notes on the guitar. This will sound a little like a theremin. The cleaner you play, the easier it tracks the pitch. Playing chords or letting many strings ring will make it more unpredictable.

(Note also, we have wheels three and four set to 4. This removes a lot of high frequencies to make the PLL more stable.

Also, wheel ten is set to 4, which adds some midrange filtering and clipping, and wheel eleven is set to 5 to cut some high frequencies from the whole sound.)

Try changing wheel 8 to different settings now, and hear the different modes of the PLL.

Here is another setting:
09559005000

The PLL Settings Are:

- 0 OFF/BYPASS just pass signal
- 1 Slow portamento wobbly note
- 2 Faster portamento wobbly note
- 3 Slow portamento buzzier
- 4 Faster glitchy
- 5 Cronky sounding
- 6 Cronkier sounding
- 7 Very slow portamento, stable pitch
- 8 Amplitude modulated by PLL slow tracking. Sounds like ring mod. It switches at audio rates between the signal after the octave drive and the signal right after first fuzz stage before the EQ
- 9 Same as 8 but with faster tracking

PLL Positions 8 and 9 on wheel 8 sound like a kind of amplitude modulation.

In these modes, the PLL circuit switches very quickly (at the input freq) between the audio signal from just after the octave fuzz, and from just after the first opamp gain stage (wheels 2, 3, 4).

The rate at which it switches is the pitch the PLL is detecting. (This is still from after the octave fuzz as normal.)

The range and speed at which the PLL tracks are different for positions 8 and 9

So changing the EQ (wheel 5) and the octave fuzz (wheels 6 + 7) will affect the tracking of the PLL and also one of the two signals.

VERY COOL FEATURE!

This sounds more buzzy and broken, and we have changed the tone wheel (five) to position 9 (bypass) to allow more high frequencies into the PLL.

Perhaps we can refine this a bit more to make a sound almost, but not entirely unlike a stylophone:
43450005040

Settings 8 and 9 on the PLL wheel are a kind of amplitude modulation, so you hear the guitar sound with a sort of ring mod at the speed of the PLL.

Try this:
90550009000

It's quite a strange space sound on position 8:
90550008000

Wheel NINE: BIAS OFFSET

This controls the 'zero' position of the waveform for the opamps doing the fuzz loop, the first tone buffer, and after the octave fuzz.

Changing this moves the whole waveform up and down. As there are limits to how far it can move, this will mean the top or bottom of the waveform will become clipped. This can sound a bit chopped or nasty, but can also work with assymetric clipping at the fuzz stage in useful ways. After changing this wheel, it will take about five seconds for the circuit to stabilise to the new values, so you might not hear any change immediately. Setting 0 on the wheel is the most neutral setting, with the bias in the centre.

1–5 makes the bias more negative, with 5 being the most negative.

6–9 makes the bias more positive, with 6 being the most positive, and 9 being back close to the centre.

Try this sound:
09330000000

And now with maximum negative bias:
09330000500

And now with max positive bias:
09330000600

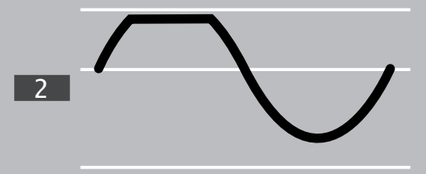
These sound kinda similar, as due to using symmetric clipping earlier in the chain (wheels three and four are set both to 3), it doesn't really make that much difference which side of the waveform we clip.

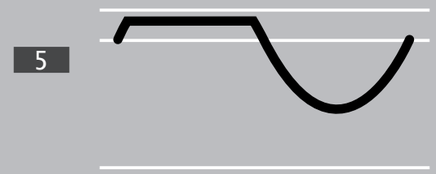
However, compare these two:
09300005000

And:
09300006000

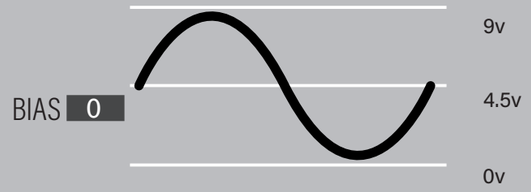
Now settings 5 and 6 sound really different, as wheel four has been changed to setting 0 and so the clipping earlier in the chain is asymmetric.

BIAS OFFSET Waveshape Diagrams



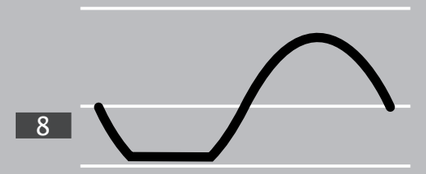


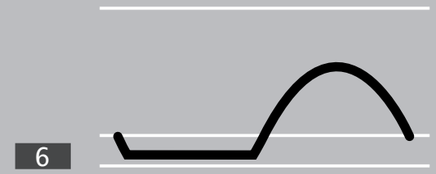
Position '0' on wheel nine is the default position, which sets the bias to the normal centred level.



Going up or down from the zero position goes slowly towards the extremes, hence wheel position '5' and '6' on the bias control are the most extreme settings.

It's also useful to be able to go between the extremes quickly, so you can quickly change from '5' to '6' and back to hear more obviously what the bias is doing.





Wheel TEN: OUTPUT CLIP 

This is a sort of clipping that is more traditional and controlled distortion than the Opamp fuzz clipping, and is all about reducing the apparent gain, but also giving the effect of much longer sustain/smoother fuzz sounds.

It works mostly by having two back to back diodes, but there are some unusual modes too.

It's almost right at the end of the processing chain, and thus affects the sound of everything else.

As this is about clipping the waveform, it makes it quieter, and you will probably have to turn up the output volume, especially on the higher settings.

The higher the number, the stronger and/or more coloured the sound.

Wheel ELEVEN: OUTPUT TONE 

This wheel controls a one pole low pass filter.

In position 0 it is bypassed.

From position 1 to 9 the frequency of the lowpass is reduced. So 9 has the least treble.

Changing the settings of wheel 11 actually changes the frequencies that the filter sits at rather than just lowering the gain of a fixed frequency filter

The Components of Wheel TEN

0 OFF

1 Blue and green LEDS. Just shaves a bit off the top of the signal and adds a few more harmonics. These light up!*

2 Just red LEDS. Shaves off more, harder and brighter sound

3 1N4148 silicon diodes, but with 1K resistor in series. Hardish clip at a lower voltage

4 1N60P diodes, with 47N cap in series. Cuts treble, only on peaks of waveform! Sounds midrangey and pokey

5 1N60P diodes with 1uf cap in series. More treble cut, quieter and deeper sound

6 1N60P diodes with 1K resistor in series. Brighter, but quieter, more sustain

7 1N4148 diodes. Hard clip. Quiet

8 1N60P diodes. Even more clip. Quieter

9 Germanium diodes. Most clip. Quietest, most sustain

** But you can't see them because they are hidden inside the enclosure but trust us it's a tiny disco in there*

ANDY TAYLOR ------ andytguitarist.co.uk

We lent a unit to our friend - Session Guitarist, Composer and Educator Andy Taylor - to see what he made of it. Like most musicians, he decided to dive right in without reading (this) the manual. His thoughts and a few presets he discovered are below.

Here lies my challenge!

btw… I'm going to Fuzz around and find out, I'm not going to use the manual (hey I'm a guitarist)…

Gear used…
guitar: Powers Electric A-Type (single coils)
amp: AC30 Top Boost (set clean)

Aim: to find a range of preset tones that are selectable by scrolling through only one wheel… (switching only the first wheel)

Preset 1 08769000004
low-mid gain amp-like foundation tone with hairy to biting pick dynamics and useful cleanup from the guitar volume knob.

Preset 2 78769000004
mid-high gain amp-like foundation tone with more sustain while retaining string to string clarity and biting pick dynamics. Useful cleanup from the guitar volume knob.

Preset 3 98769000004
Fuzzed out amp tone. Reminiscent of classic Fuzz Face on neck pickup, only gated. Single notes cut through while cutting noise between notes, win win!

With these presets I have a range of base tones I can access quickly and easily, either between songs on stage or when tracking in a studio session!

There are many crazy and original sounds to be found in this pedal (some I have never heard before in a fuzz unit), but already I have the basic food groups covered in the above presets (and many more similar combinations available) to warrant this becoming my main (and perhaps only) distortion unit on my pedalboard!

I love it already, what a great pedal!

(I don't know why I wrote most of this like I'm a Guitar mag reviewer, it just happened that way).

A couple more wilder beast presets…

Preset 4 66659040003 "Thrashes To Ashes" Ramones mid rich punk tone

Preset 5 66659049005 one wheel click away from preset 4 brings in some oscillation behind the fury.

Preset 6 Click the same (!) wheel down to 8 for some arcade alien intervention.

Preset 7 Click down to 7 on the (!) wheel and now the cops are coming.

Preset 8 66669644213 "3D Plasma Tanx" lightly strum the wound strings to keep the tank moving while striking the unwound strings to fire!

Now I'm going to read the manual!

EXAMPLES FOR BASS DI

Use these with guit level in, line level out:

Fuzzybass	07000020003
Bias funky tones	40040450500
Funky Tony Bias	40040450600
Pokey Little Number	04030000507
Square Marching Shin	33540002004
Mothership Collision	43530990056
Slight Limp	20339000001
That Filthy Badger	99270650651

EXAMPLES FOR GUITAR WITH AMP

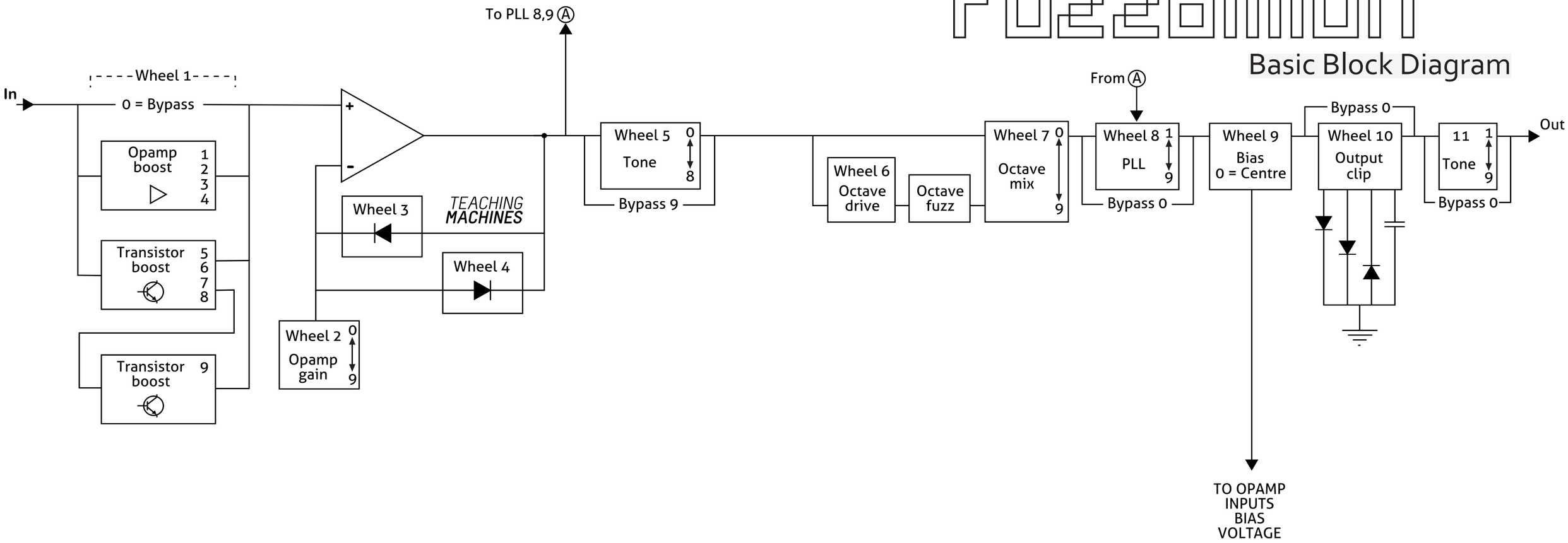
70s Fuzz solo	29100140072
Sine Wave Mania	04000068000
BAD IDEA	95902250594
SUPER DISASTER	99009290669
DEATH TONE	99991250457
FILTH	99092040088
Heavily Biased	99092040768
Always Feedback	49229000098
Bias Rhythm	28092000541
Bright Rockbox	28032000091
Compressed Drive	29220100085
All kinds of Wrong	29046990599
Thereminish	99449007045
PLL Quite Nice	49440002551
Brassy Solo	90444490655
PLL Guit to Bass	36442026356
Flattish	10559000000
Crunchy Rhythm Nice	49100000000
Good Food PLL	09559007000
PLL Stylophone	43450005040
Another Rhythmic Epic	49122000051
Heavy Sludge Tone	98459340052
Heavy Sludge Tone II	48459340050
HATE I THANKS IT	82353930324
PLL Funky Clav	49222006551
Harrisonal	56019000006
PLL Ultra Flurple	49440004551
Hippy Fuzz Jam Solo	49300060634
Emergancie	99090990545
Just a Lil Boost	00009000000
Sky Spirit	89000000001
Space Lead Bassy Riff	49890090005
Sharp Attack	68656000146

Fuzzillion Cheat Sheet

	Wheel 1 Input Boost	Wheel 2 Fuzz Loop Gain	Wheel 3 Upper Fuzz Loop Clip	Wheel 4 Lower Fuzz Loop Clip	Wheel 5 Tone	Wheel 6 Octave Fuzz Drive	Wheel 7 Octave Fuzz Mix	Wheel 8 PLL Mode	Wheel 9 Bias	Wheel 10 Output Clipping	Wheel 11 Output Tone
9	Double fuzzy boost	Highest gain	Ruthless clip (louder)	Ruthless clip (louder)	Bypass	Most drive	Most octave fuzz	Slow ring mod PLL	Least positive bias	Germanium clip	Most treble cut
8	Fuzzy boost gain 4		Hard clip (louder)	Hard clip (louder)	Most treble			Ring mod PLL	+	Yet more silicon clip	
7	Fuzzy boost gain 3		Firm clip (louder)	Firm clip (louder)				Very slow PLL	++	Even more silicon clip	
6	Fuzzy boost gain 2		Soft clip (louder)	Soft clip (louder)				Cronkier PLL	Most positive bias	More silicon clip	
5	Fuzzy boost gain 1		Max Volume	Max Volume				Cronky PLL	Most negative bias	Bassy clip	
4	Clean boost gain 4		Tone cut	Tone cut				Fast glitchy PLL	---	Midrange clip	
3	Clean boost gain 3		Ruthless clip	Ruthless clip				Slow glitchy PLL	--	Slight silicon clipping	
2	Clean boost gain 2		Hard clip	Hard clip				Fast PLL	-	More LED clipping	
1	Clean boost gain 1		Firm clip	Firm clip				Slow PLL	Least negative bias	Slight LED clipping	Least treble cut
0	Bypass	Lowest gain	Soft clip	Soft clip	Most bass	Least drive	Least octave fuzz	Bypass	Bypass	Bypass	Bypass

Fuzzbillion

Basic Block Diagram



Techy HINTS n TIPS

Here are some additional technical notes some people may find interesting. But you don't need to understand it all to enjoy the pedal to its fullest!

The greatest amounts of distortion are from the most clipping, rather than the loudest sound. Position 9 on wheel 10 can give the most clipping, even though the output level sounds quieter.

Wheel 10 really gives the overall character of the effect. It's worth trying leaving this on a setting like 9, 6,5 or 4 and then changing the preceding wheels to shape the signal, rather than constantly changing wheel 10. For creating more metal kinds of distortion, try leaving it on position 5.

The Fuzzbillion has true (hard passive switched) bypass when using guitar level or line level in and out, but not when the switches are set to use a different combination of the two. (I.e, not true bypass when using a combination of switches for line in and guitar out, or guitar in and line out.)

It's quite easy to overdrive the output transformers in line output mode. This is intentional, as it's a kind of saturation that can be useful. So try turning up the output knob, and turning down the input gain on the device the outpu t is connected to.

At extreme settings, the waveform will go towards a narrow sharp sawtooth rather than a square, as the transformer primary becomes totally saturated.

You can use the line output setting when using the pedal straight into a guitar amp. The transformers add some pleasant colouration even at low volume, and a roll off of lower frequencies around 50hz. Just be careful to keep the output level low or it will be very loud!

The line input mode isn't very useful with guitar, as the 1K impedance is much lower than the 3M impedance from the guitar mode. This tends to make the guitar sound a bit dull and weak in line mode. However, it might lead to some useful sounds anyway.
As the inputs of the Fuzzbillion are balanced in line mode, you can plug a dynamic mic like an SM57 directly into it, using an XLR to 1/4 inch TRR balanced jack cable.

This will cancel hum and cable noise on the input in the same way as any mic preamp with a balanced input. There should be enough gain to provide a useful line output level. Of course, it tends to be a rather more saturated and noisier than a normal mic preamp, but it's fun to try for things like a dirt mic for drums.

The guitar input mode and using a balanced or unbalanced cable with a dynamic mic will also work, but may have more hum.

Position 1 on wheel one has less gain than the bypass position 0 This can be useful when you want less distortion and a slight treble cut, or are using a hot line input. Also, positions 1-9 all have slightly less treble than the bypass position.

The capacitor setting 4 on wheels 3 and 4 have different values for the capacitors that cut the treble. On wheel 3, this allows more higher frequencies than wheel 4.

The PLL has a Schmitt trigger before it.
Positions 1-5 on wheel 9 (Bias) will make this more sensitive, and positions 6-9 will make it less sensitive.

The Schmitt trigger creates a cleaner square wave to help the PLL to track the pitch. It is a logic gate that switches on and off at different voltage levels, and it helps clean up noisy signals as the voltage level it turns on is much higher than the off level. Because of this, it rejects parts of the waveform that are not clearly on or off, or that wobble too closely between on and off too much. The bias (wheel 9) makes a big difference to how it operates. 1-5 on wheel 9 put the average level of the signal higher, which means the Schmitt trigger is more sensitive, and more likely to distinguish an 'on' from the original waveform. 6-9 bias the signal the other way, which makes it less likely to distinguish an 'on' and less sensitive.

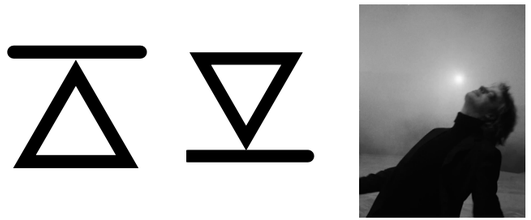
There is AC coupling in many places in the Fuzzbillion, so looking at the output waveform on an oscilloscope doesn't always help to understand how the clipping and bias is affecting the sound, because the AC coupling will remove DC offsets by the time it gets to the output.

Digging Deep into Wheels 3 + 4 with Frank

The earlier explanation for wheels 3 and 4 is a little misleading. I feel I should give a more accurate explanation, even though it's probably far more confusing compared to the earlier one if you are not familiar with opamps and negative feedback. However, some mysteries of why it sounds a certain way will become clearer!

What is really going on electrically is more complex, but harder to explain. As the diodes and other components are in the negative feedback loop of the opamp, what they are really doing is changing the *gain* of the various upper and lower halves of the waveform, rather than introducing a brick wall clipping effect. This is why they sound so different to the simple diode clipping in wheel 10.

When you change from a germanium to a silicon diode on wheels 3 and 4, two things happen. The first is that there is more crossover distortion at the zero crossing point, as the silicon diode will not be



conducting at the very lowest voltages, and so there is much higher gain at the lowest voltages. (There is a fixed resistor in parallel with the diodes in the feedback loop. When the diode is not conducting it is effectively removed out of the circuit, and only this resistor is setting the gain. As it is a *negative* feedback loop, the more conduction, the *lower* the gain.)

This is why there is always a little fizzy quiet distortion in this opamp stage, as the crossover gain brings up the very lowest levels before the higher ones are clipped (except in wheel position 5 on wheels 3 and 4 that removes all the diodes and other components from the negative feedback loop, and just leaves the fixed resistor).

The second thing that happens as you increase wheels 2 and 3 from positions 0 to 3 is that the opamp is more likely to clip, as the silicon diode starts to conduct and hence *reduce* gain at a higher voltage. This means we are warping both the signal near the 'zero' crossing point, and at the peaks. When using the LED setting 3 on wheels 3 and 4, this has the effect of sounding like a mix of clean and distorted signals, as there is lots of gain in the lower parts of the waveform (near 'zero') and also some clipping on the peaks, but between that the waveform is relatively unscathed.

Try 09339000000 and adjusting how hard you play chords on a guitar to hear this more clearly.

The capacitor position 4 also has a complex effect here when combined with a diode on wheels 2 and 3. The Fuzzbillion works internally on a single ended supply, like a conventional guitar pedal. We have +9V and ground, and the signal therefore has to be biased around 4.5v when using opamps (this is the 'zero' bias point that can be changed using wheel 9).

The gain of the feedback loop is also adjusted by a capacitor and variable resistor (via wheel 2) to ground in the negative feedback loop. So the voltage on one side of the feedback loop, and hence across the diodes, will drop as gain is increased (remember this is negative feedback).

As there is a capacitor to ground here, there is an additional time constant that will be noticeable as a kind of compression and bias shifting when using settings like 09439000100 Further changing the bias using wheel 9 can increase this effect to the point where there is a very slow attack envelope on the sound.

Congratulations

You have reached the end of the manual. You now know enough to press ALL of the buttons on the FuzzBillion with confidence.

If you're still hungry for more insight, head to our Youtube channel **@teachingmachinestv** where you'll find funformative demo videos.

Description	Number

Description	Number

Description	Number

Description	Number

Description	Number

Description	Number

Description	Number

Description	Number

Thanks

Thanks to everyone who has helped us in any way.

There are too many to name and we might forget someone so we're just going to leave it at that but special thanks must go to you the customer without whom we obviously would not exist as a company.