Electronic Bagpipes

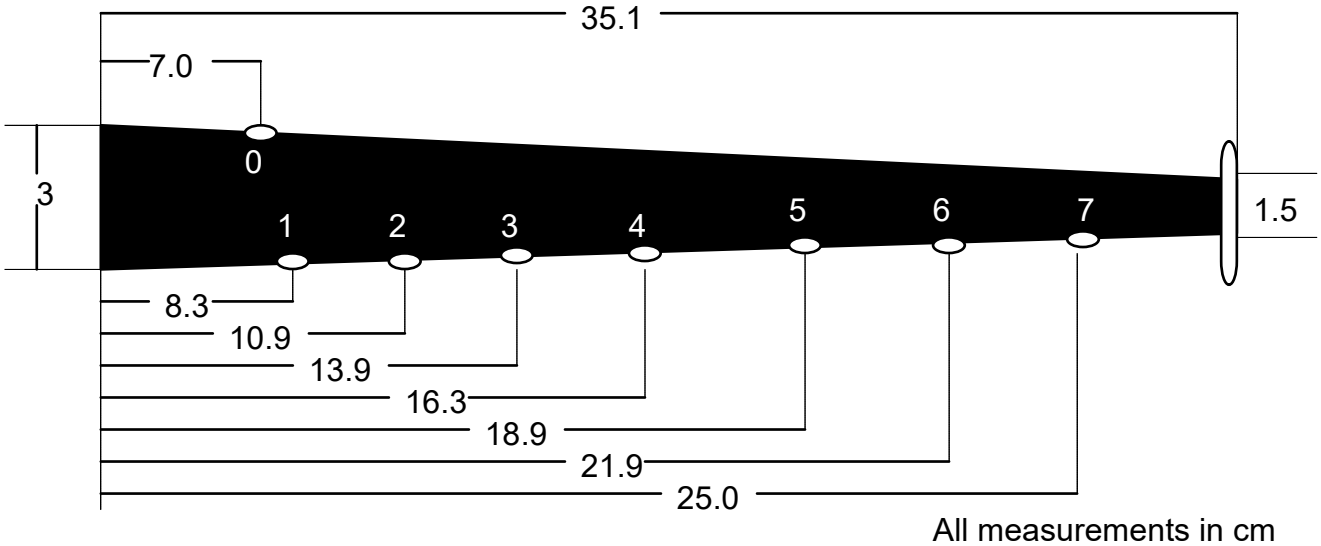
Specification

Operates from a 9 - 14V supply.
One bass drone. (116.5Hz)
One tenor drone. (233Hz)
Chanter tuning from low G to high A.
Output via an internal 1W amplifier or by line output to an external amplifier.
The harmonic content of the sound of reed bagpipes is approximated by using electronic ramp generators.

The Chanter

Bagpipes have only seven notes to the octave, and as a result the notes do not correspond with the standard notes when there are the usual 12 notes to the octave. There are several standards for the tuning of the Chanter (and correspondingly the drones) and the table below shows the one chosen for this project. The Chanter has seven playing holes on the front and one at the back.

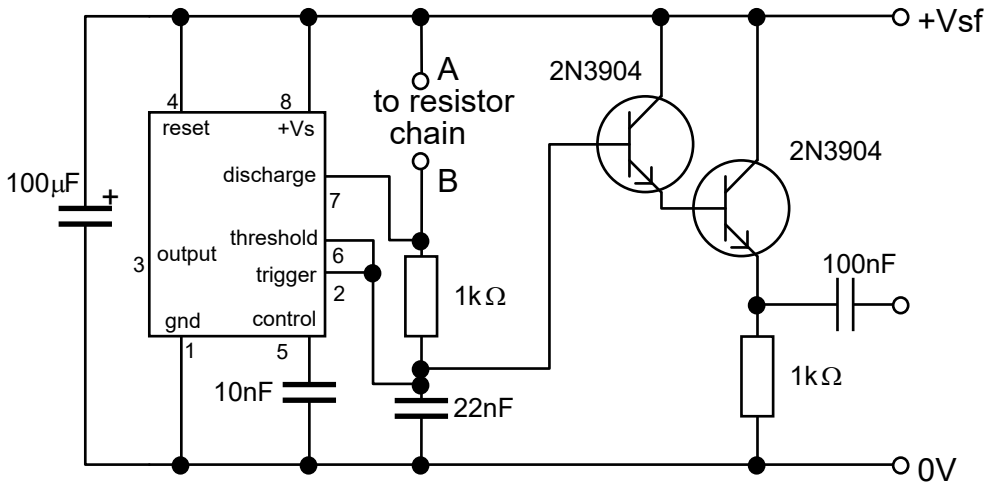
Approx. Notes	**G**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**A**	
Frequency Hz	414	466	524	583	629	699	777	839	932	Resistors Ω
Back hole 0	X	X	X	X	X	X	X	X	O	22023
Front hole 1	X	X	X	X	X	X	X	O	O	6238
Front hole 2	X	X	X	X	X	X	O	O	O	9420
Front hole 3	X	X	X	X	X	O	O	O	X	46918
Front hole 4	X	X	X	X	O	X	X	X	X	8228
Front hole 5	X	X	X	O	O	X	X	X	X	30347
Front hole 6	X	X	O	O	O	X	X	X	X	15580
Front hole 7	X	O	O	X	X	O	O	O	O	17679



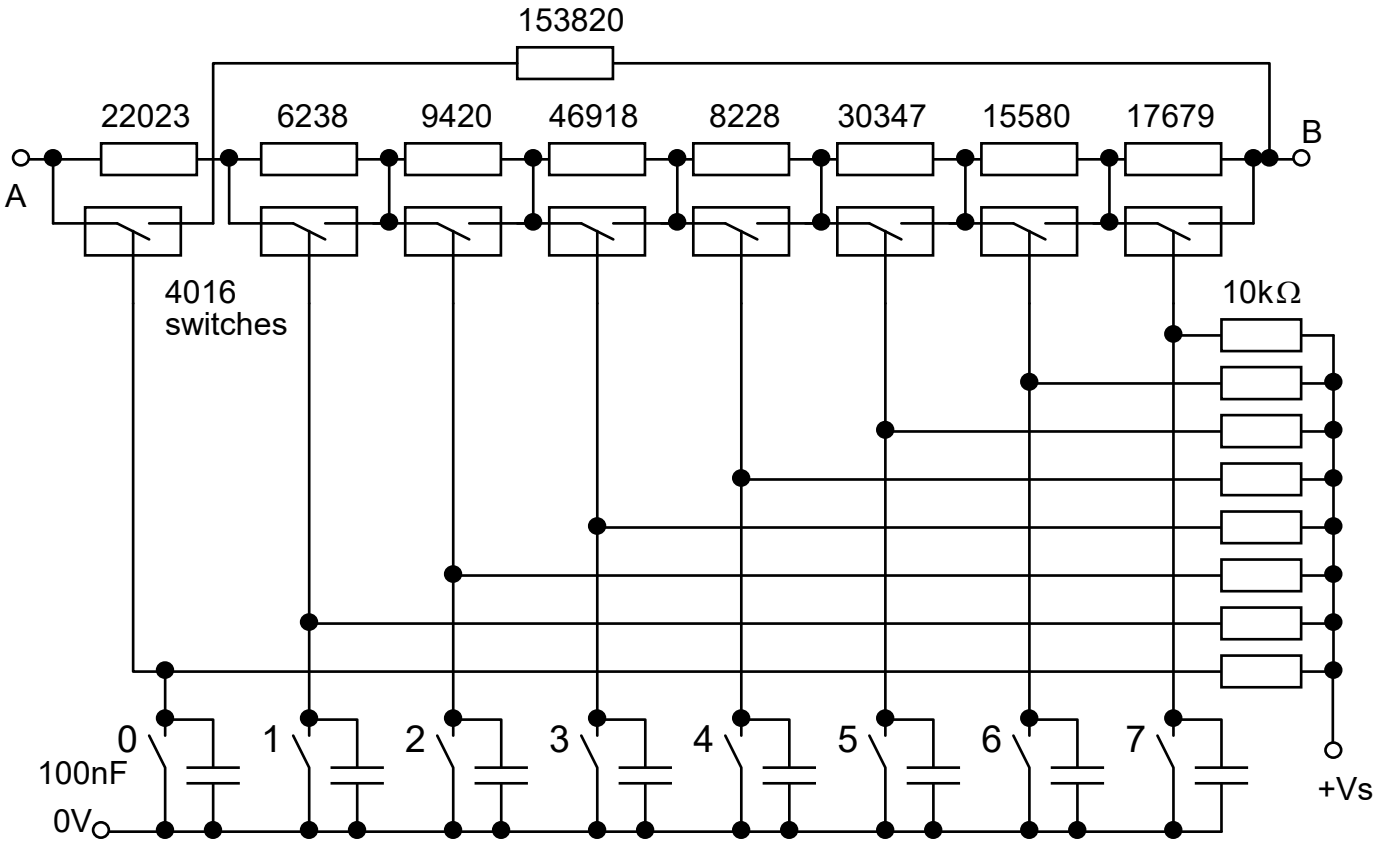
The diagram above show the measurements for a typical chanter. However, since the tuning is electronic, the actual sizes do not affect the pitch of the notes. The holes contained small tactile switches, wired through a hole running along the length of the chanter.

Chanter circuit diagram

The circuit is a fairly traditional 555 astable. The output is taken from across the timing capacitor and is buffered by the Darlington pair made from the two 2N3904 transistors.
The resistor values were calculated based on the circuit below.

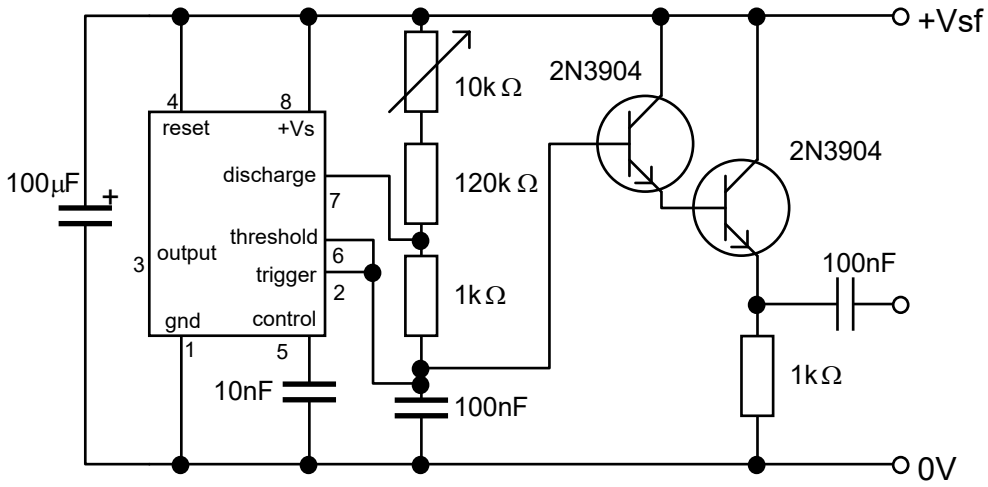


The resistor chain.



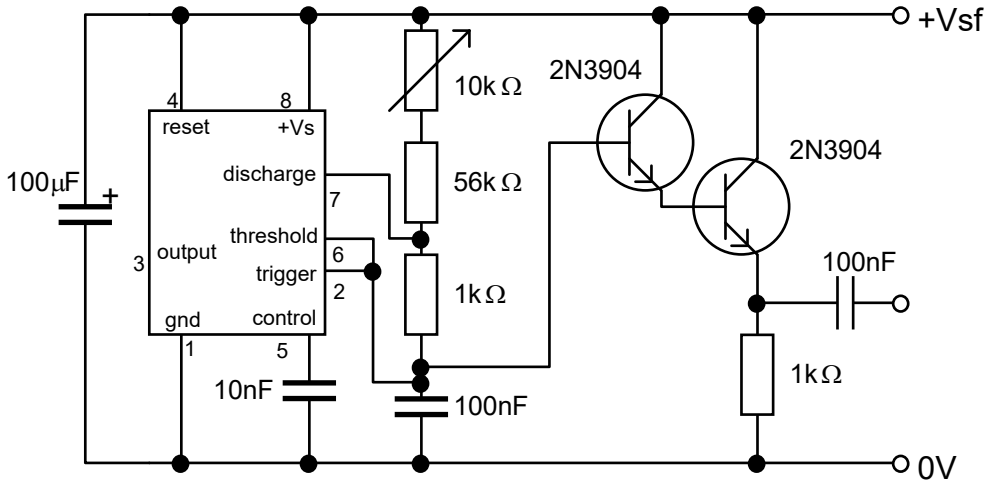
The switches on the chanter were small tactile (NO) switches. These were used to switch 4016 electronic switches and were debounced using the 10kΩ pull up resistors and the 100nF capacitors across each tactile switch.
To sound top A, the total resistance between A and B with the correct front switches pressed is 123095Ω and the resistance required to sound top A is 68377Ω. So the back switch (switch 0), switches a 153820Ω resistor in parallel with the resistor chain to obtain the correct resistance and frequency.

Bass Drone circuit diagram



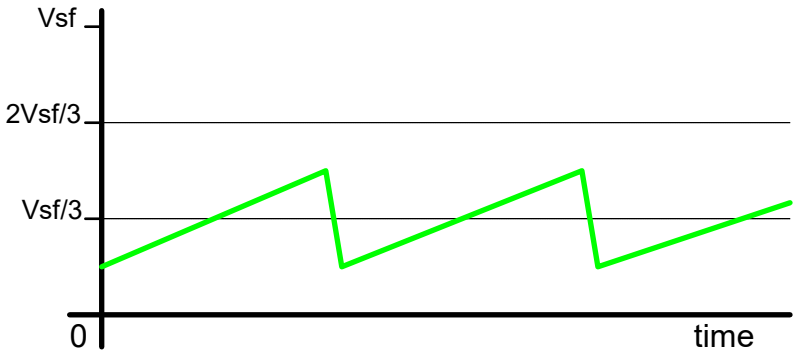
The frequency is tuned using the 10kΩ adjustable resistor. The frequency should be 116.5Hz.

Tenor Drone circuit diagram

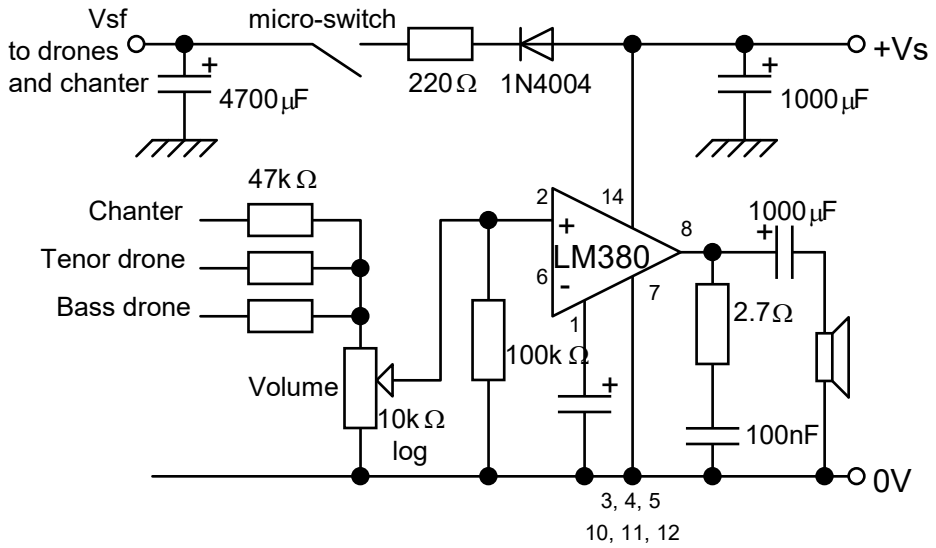


This is the same as the bass drone but with different timing resistors.
The frequency should be adjusted to 233Hz.
Additional tenor drones can be added as needed - many bagpipes contain two tenor drones.
Although additional drones will be set to the same frequency, their phase will change relative to one another producing a very low frequency beat.

The drones and chanter circuits produce a ramp waveform shown opposite. This waveform contains both odd and even harmonics, so matching the harmonic content of the drones and chanter.
The waveform is ≈ 1.2V below a third of the drone and chanter supply voltage.



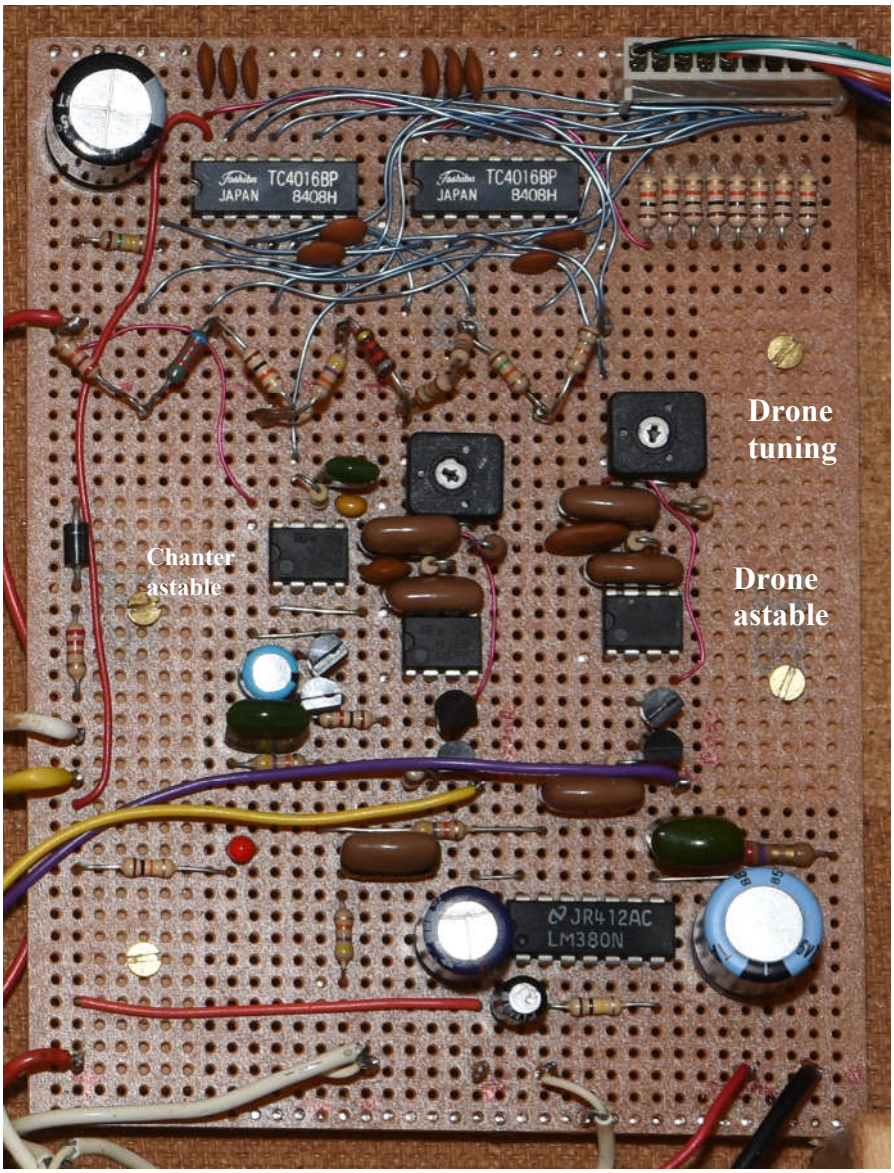
Mixer and Amplifier Circuit Diagram



The output amplifier is a standard LM380 circuit which will deliver around 1W to an internal speaker.
The Chanter and Drones are mixed via the 47kΩ resistors connected to the volume control.

To simulate the effect of blowing into the mouth piece and inflating the air sack and then squashing the air sack with your arm to provide the pressure for the Chanter and Drones, a micro-switch is put into the power supply line to the Chanter and Drones.
When the micro-switch is pressed (using your left arm), the 4700μF is charged via the 220Ω resistor. When the micro-switch is released, the Chanter and Drone circuits slowly discharge the capacitor, so changing their loudness. The 555 astable circuits will maintain a reasonably stable frequency down to a supply voltage of approximately 3V, though the waveform distorts below approximately 4V.

Circuit board



To chanter switches

Chanter resistor chain

To micro-switch

Power amplifier