…Synth DIY: Gate Buffer

One of the simplest DIY utility circuits you can build is a gate buffer: you put a gate signal into one end, and get a gate signal out of the other.

Although this might sound unnecessary, there are several reasons you might want a gate buffer:

- compatibility problems between gate/trigger inputs and outputs on different equipment: see my page on the Arturia Beatstep (https://synthnerd.wordpress.com/arturia-beatstep/), for example
- the need to trigger multiple devices from one source: passive splitter cables or mults sometimes result in signal loss and therefore unreliable triggering
- tightening up the edges of gates/triggers: for various technical reasons, some trigger outputs are relatively slow to rise and/or fall; in a worst-case scenario, this can skew the timing of down-line devices. A buffer with multiple outputs can deliver a set of tight, sharp pulses simultaneously.

I offer two simple designs here, one using discrete components, the other using an op amp. Both require just a handful of parts, both will run off a wide range of DC supply, including a 9V battery, and both can be made very compact if you ever want to include them inside another piece of equipment as part of a build or mod.

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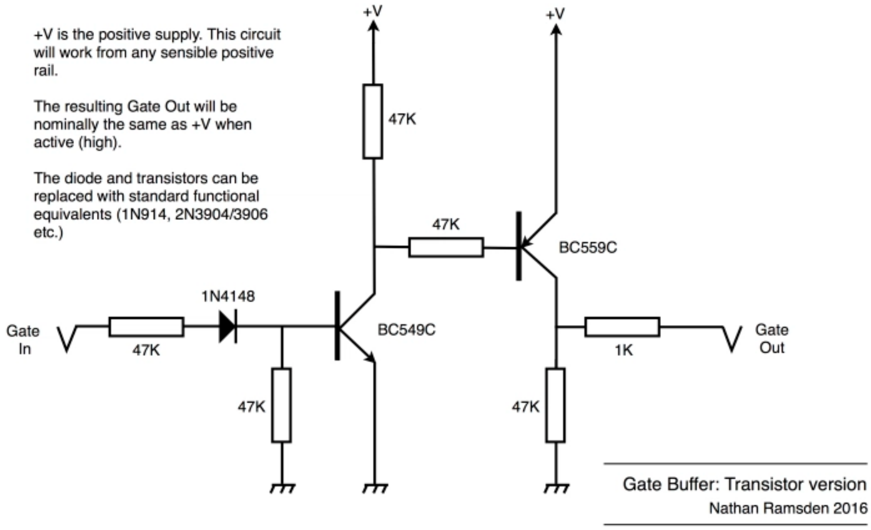
Discrete (transistor) Buffer

The transistor buffer is a two-stage circuit, with each stage inverting the incoming signal.

Think of a gate signal as a logic on, or a logic off. When there is no gate present, the first transistor is held off by its base resistor. The base of the second transistor is therefore tied to +V by the two 47k resistors; as it is a PNP type, it is therefore off, and the output is held low.

Conversely, when the input is high, the first transistor is switched on, and the base of the second transistor is taken low. This pushes the second transistor into conduction, and the output is taken high.

Precise voltage levels depend upon the level of the gate signal going in, and the positive supply rail. The circuit will operate on a wide range of positive DC supply: in a 5V logic circuit, from a 9V battery, a 12V or 15V rail in a Eurorack system, etc. The input resistors and diode provide input protection; so, for example, you can send a bipolar square LFO into it with no ill effects, or use it to make a reliable 9V gate from a 15V one without the impedance issues of a simple passive potential divider. It will also allow you to increase a low gate to a high one, so you could (for example) run a 5V signal into this, powered on an existing 15V rail, and get a 15V gate out. With a standard signal diode and two normal low-power transistors, you can trigger this circuit with just a couple of volts.



(https://synthnerd.files.wordpress.com/2016/03/gate-buffer.jpg)
Gate Buffer: Transistor version

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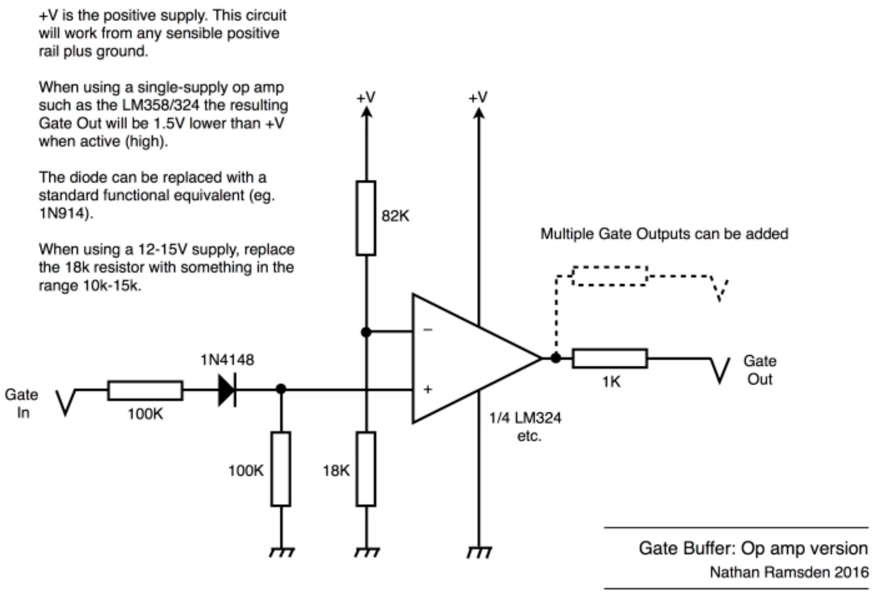
Op Amp Buffer

The op amp version of this gate buffer circuit consists of a single op amp stage set up as a comparator: one voltage is compared to another, and the output goes high or low depending which input is the higher.

The potential divider at the inverting input provides our reference voltage. The non-inverting input takes the external gate signal we want to buffer.

When there is no gate signal, or it is low, the inverting input is higher, and the output is therefore low. When the gate signal is high, the non-inverting input is higher, and the output is high.



(https://synthnerd.files.wordpress.com/2016/03/op-amp-gate-buffer.jpg)
Gate buffer: op amp version

The circuit is designed to run from a single-sided supply, ie. ground and positive. For this purpose, an op amp such as the LM158/358/324 (single, dual, and quad versions respectively) is suitable as the low output state goes to the 0V rail. Their high output state is around 1.5V below positive supply.

The voltage reference provided by the potential divider at the inverting input should be adjusted for purpose: using a 9V supply, the values given will trigger the comparator at around 1.6V; even with a low battery, this circuit should trigger around 1.2V. With a 12V or 15V supply, replace the 18k resistor with something in the region of 10k-15k. This would keep the trigger level around 2V or a little lower, which is high enough to be a clear ‘on’ signal, but not so low as to be confused with a slightly high ‘off’ signal (the Arturia Beatstep ‘off’ gate signal hovers around 0.6V, for example).

It would be possible to use a dual-rail op amp just as well, which would require the addition of a diode on the output to clip the negative-going signal.

I have used an op amp here rather than a dedicated comparator; devices such as the 311 cannot be directly substituted in this circuit.