# Recovering with Mario, using active components

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## 1 Introduction

There have been some discussion about active vs. passive components for modding of the Gamecube controller, so I tough I could show some capabilities of active components, in case anybody wondered how illegal mods can be done without any form of CPU. In this paper I will present an idea on how to mash that B button very very fast with no sweat.

## 2 Active vs passive

The difference between the two types of components can be summarized by if the component needs external power to operate or not. A resistor or a capacitor for example is classified as a passive components, while semiconductors belongs to the active group. However the real problems start with transistors being introduced to the mix of components used. They are a subset of semiconductors but can be used to many many things. Both the 555 timer and the MUX discussed here have multiple of transistors within them.

## 3 The MUX

A multiplexer (MUX) is a switch where one can control which one of many signals on the input are let through the output. Think of it like its a bridge with only one lane, where many roads go to the bridge. Only one road is opened at a time for the cars to go over the bridge, and its controlled by a switch which says "road one open", "road two open", "road three open" etc. For our purpose the multiplexer will be used to switch between "standard" controls of the Gamecube controller and "modded" controls. There exists many types of multiplexers but in our case a 2-to-1 multiplexer will do.

## 4 The 555 timer

Welcome to the magical land of multivibrators (I didn't come up with this name). The 555 timer is an IC (Integrated Circuit, those black rectangular

bugs with metal legs), which makes it easy to make a "clock" signal (clock as in computer clock as in something that goes "on, "off", "on", "off" rapidly, repeatedly in the same tempo.). The configuration of this circuit is described more in detail here: [1] (ctrl F "50% Duty Cycle Astable Oscillator"). In this circuit there are only two passive components that needs to be calculated.

### 4.1 Math, skip this if you want

Since the game runs on 60 fps and the polling rate is about the same, I will assume that the best signal for our clock signal would be 30 hz, 50% duty cycle to not miss too many frames. If the sampling rate of the game (60hz) is lower than two times the clock (see Nyquist–Shannon sampling theorem [2]), a silly thing occurs called aliasing. Aliasing is sub optimal, as some cycles will not be recorded by the game as if the clock signal was lower frequency than it actually is. Using the configuration shown in [1] the formula $f = 1/(0.693(2R_2)C)$ is given and can be rewritten to $R_2 = 1/(0.693(2f)C)$. I choose C = 100nF and calculate $R_2 = 1/(0.693 \cdot 2 \cdot 30 \cdot 100 \cdot 10^{-9}) = 240500.2405$ so $R_2$ should be about $240k\Omega$.

## 5 putting it all together

Now that our clock signal and our MUX is up and running, the circuit needs to be inserted in the Gamecube controller. One way of doing this is cutting the signal for B and inserting the MUX there. On one input the MUX gets normal B and on the other input it gets the clock. The output of the MUX is connected where normal B used to be connected. The switch on the MUX can be wired to any other button then B.

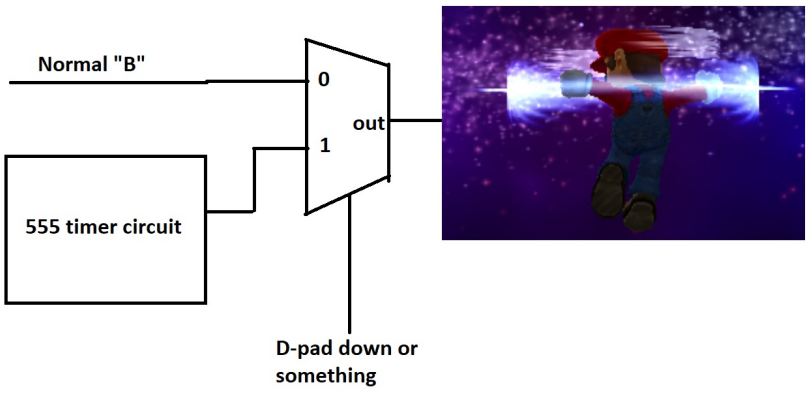


Figure 1: Did someone say turbo?

# 6 Conclusion

While this mod probably needs some refining (looking at you 5V output signal, and the 555 timer can probably be replaced, and a "turbo button" to activate turbo on all buttons etc...), it does show how active components can be used to make mods that approaches what is possible with an arduino installed. If somebody really wanted they could extend this mod to make a multishine button without much problems. I however don't think active component should be straight up banned, but there is definitely a grayish-black zone for their use in tournament play.

# References


[1] *555 Oscillator Tutorial - The Astable Multivibrator*. URL: `https://www.electronics-tutorials.ws/waveforms/555_oscillator.html`.

[2] *Nyquist–Shannon sampling theorem*. Aug. 2018. URL: `https://en.wikipedia.org/wiki/Nyquist%E2%80%93Shannon_sampling_theorem`.