

# Introduction to Video Switcher

<http://lobes.usc.edu/videoSwitcher/>

Video switcher is a device to generate low contrast stimulus for visual experiments. It receives analog signal from computer video card, and drives an analog monitor to display grayscale image.

The principle is quite simple. The device attenuates the red signal to about  $1/127$  of its original, and combines the attenuated red signal with blue signal to generate a single signal, which can be fine-tuned by the amount of red and blue signals. All the 3 guns of the monitor are driven by the combined signal, so the display is in grayscale.

This is what happens when you switch the device to grayscale mode. At this mode, original blue will be white, all the green are gone (display as black), and the red is almost gone. This mode is inconvenient for daily use, so we designed a switch to allow you switch back to the normal color mode.

When the device is powered, its default mode is color mode. This means, you won't notice any change of the computer display. To enter the experiment mode, you can either call a function or press the button on the box. After your experiment is done, you call the function again or press the button to switch back to regular color mode.

# User's Manual

## Hardware Requirement

The device is compatible to any computer with graphics card with analog output (VGA). If a computer has DVI-I, DisplayPort or HDMI port, an adapter will be needed to convert it into VGA port.

## Installation

1. Turn off your computer and unplug the video cable from your computer's video port.
2. Plug one end of the supplied VGA cable into your computer's video port, and plug the other end into the switcher's input port, labeled "VGA IN". Plug the monitor's cable into the switcher's output port.
3. Secure the screws at each VGA connector using a screwdriver.
4. If you need trigger, connect the BNC port to the recording device with a BNC cable (not supplied).



## How to switch between color mode and grayscale mode?

When you turn on your computer, the display is in normal color mode. To show high-resolution grayscale images, you need to switch to grayscale mode. This can be done by a function call inside your program, or a button press on the box.

PsychVideoSwitcher in PsychToolbox 3 can be used for software switch. If you use other programming toolkit, you will need to "translate" the code.

If you use both the button and the program, you may get confused. We recommend

that you use the program or the button all the time.

### What is blue-to-red ratio (BTRR)?

A video switcher generates high grayscale resolution signal by combining the red and blue outputs of a graphics card (Fig 1). Consistent with Pelli-Zhang video attenuator (Pelli & Zhang, Vision Research, 1991, 31: 1337), the blue signal contributes to the output more than the red signal. The relative contribution of the blue and red signals to the output is determined by the blue-to-red-ratio (BTRR). The BTRR is the only parameter you concern when you program grayscale images. BTRR is the determined by several resistors:

$$BTRR = (R_{\text{attenuate}} + (R_{\text{inRed}} \parallel R_{\text{outRed}})) / (R_{\text{inBlue}} \parallel R_{\text{outBlue}}),$$

where  $R_{\text{attenuate}}$  is the  $4.7\text{k}\Omega$  resistor shown in Fig 1,  $R_{\text{in}}$  are input resistors shown in Fig 1,  $R_{\text{out}}$  are output resistors in graphics card, and  $\parallel$  symbolizes computation of parallel resistors. The  $R_{\text{in}}$  in Video Switcher are used to match the  $R_{\text{out}}$  in graphics card, and they all have the value of  $75\Omega$ , so the designed theoretical BTRR is 126.3.

The accuracy of BTRR is affected by accuracy of above 5 resistors. Normally these resistors have 1% variation, causing some variation in BTRR among different setup. However, the effect of this variation on display is very little, since it affects only the attenuated red signal. For this reason, you can simply use the designed BTRR in your code.

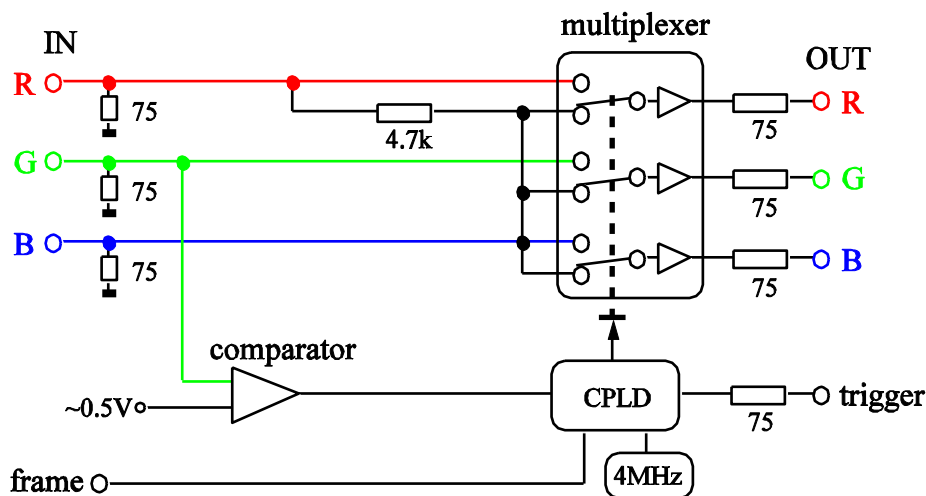


Fig 1. The schematic of a video switcher. The multiplexer has two groups of input, controlled by a voltage level. When it is in the mode shown above, the RGB channels of a monitor receive the same signal, so the display is in grayscale. The switching voltage is generated by a CPLD chip, controlled by green signal. The trigger is also controlled by green signal. Circuit may change without notice.

## How to program high-resolution grayscale image?

The PsychImaging pipeline in PsychToolbox 3 makes the program very simple, and solves the computation speed problem in old method. You are strongly recommended to use this feature. The switcherDemo.m shows how to change the contrast and orientation efficiently using PsychImaging pipeline.

## How to program trigger with accurate timing?

For researchers who record electrophysiological, fMRI response or measure reaction time to visual stimulus, it is crucial to know the exact visual stimulus onset. The Video Switcher provides a trigger output for this purpose. Since the trigger is controlled by green signal, we program the trigger in the same way as programming the visual stimulus. This will ensure good synchronization between trigger and stimulus. The program for trigger is also incorporated in PsychToolbox:

```
PsychVideoSwitcher('SetTrigger', win, vLine, nFlip);
```

The parameter vLine is the vertical location of the green signal. It is normally the first or middle line of your stimulus, so you don't worry about the delay due to vertical location at screen. You normally set nFlip to 1, giving trigger only at next flip. The switcherDemo.m also shows how to enable, set and stop the trigger.

## Specifications

- Bandwidth: ~250 MHz
- Input and output impedance: 75  $\Omega$
- Trigger output: ~4 V, 100  $\mu$ s (time delay between green and trigger is less than 10 $\mu$ s)
- BTRR: ~127 (voltage resolution is increased by about 7 bits)

## Contact us

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