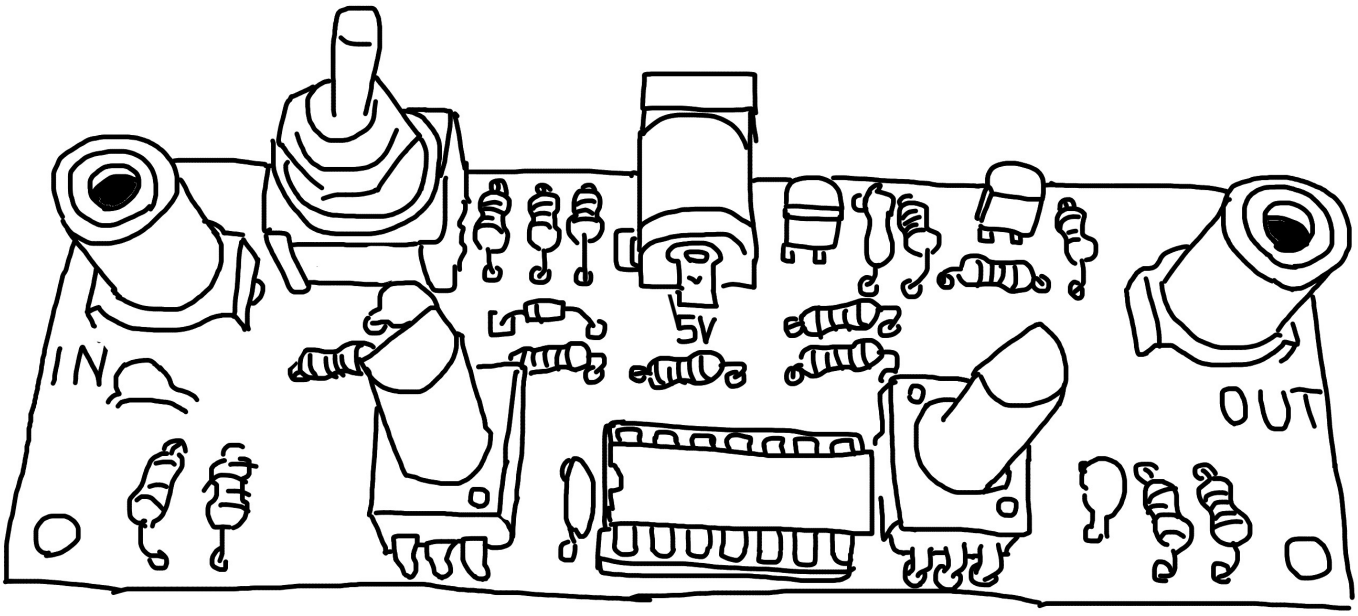
cyberboy666 & underscores.shop present
a circuit adapted from rob schafer design

two_comparator_effect

diy analog video posterization



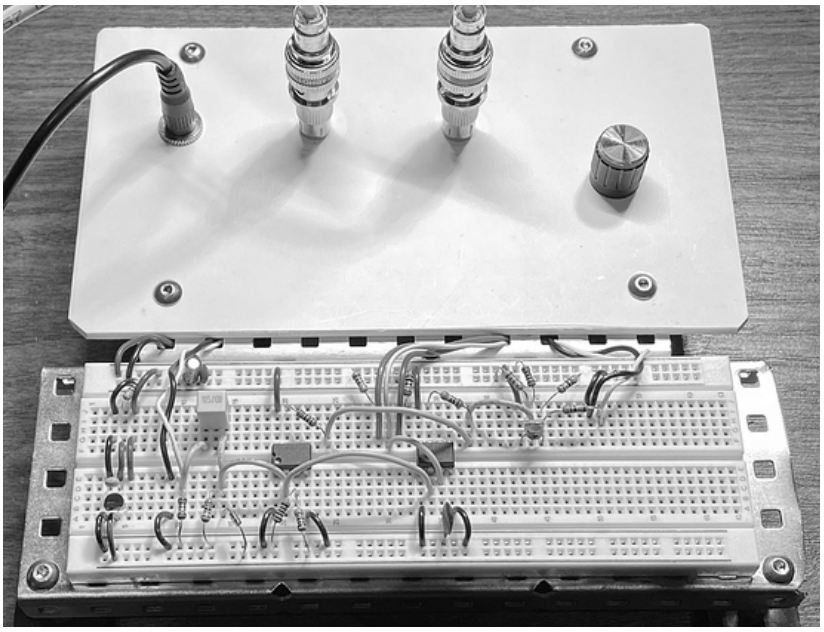
instruction manual and build guide
V0_3_1

View this project online at
underscores.shop/two_comparator_effect

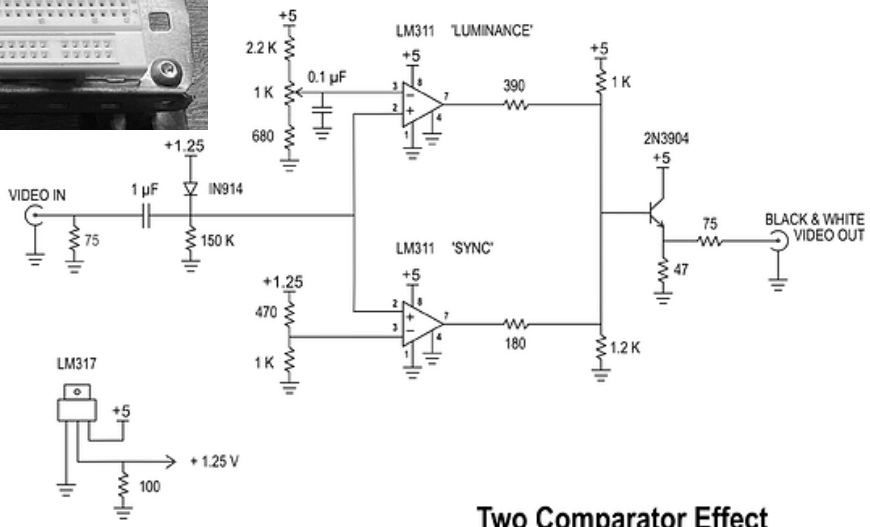
BACKGROUND

Rob Schafer designed the original version of this circuit in his excellent *whiteboard schoolhouse* youtube series.

It was updated and adapted to pcb by cyberboy666 as open-source hardware with help from the scanlines community – this version debuted as a mail-in soldering workshop for VIDICON_2020



robs original circuit, the schematic and effect shown here

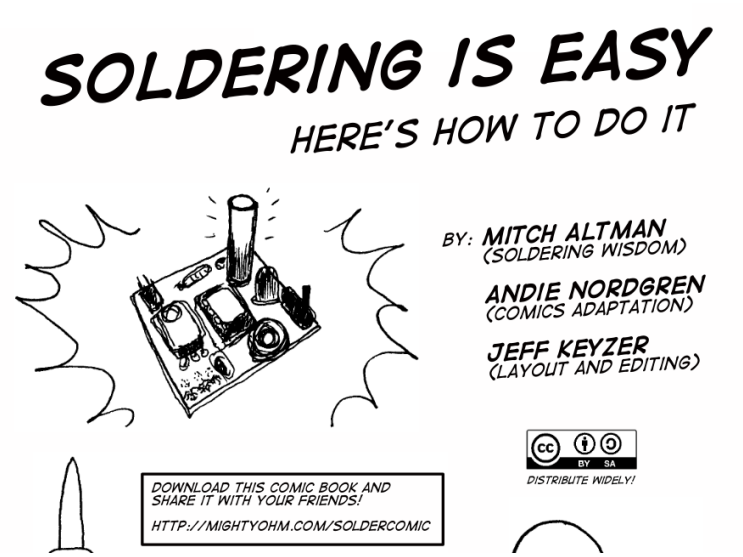


BILL OF MATERIAL

It is highly recommended to use the interactive BOM to help with placement on this build – type *kutt.it/cTyEze* into a browser or find the links from the github page

Quantity	Reference	Value
3	C3 C2 C1	1u
1	C4	0.1u
1	D1	1n914
2	J2 J1	rca
1	J3	Barrel_Jack
1	Q1	2N3904
1	R11	47
1	R12	470
1	R13	180
1	R14	1.5k
2	R15 R2	1k
1	R16	100
2	R5 R1	3k
1	R6	680
1	R7	1.2k
2	R4 R3	910
2	R8 R10	75
1	R9	150k
2	RV2 RV1	1k_pot
1	U1	LM339
1	U2	LM317
2	J1, J2	rca

BUILD INSTRUCTIONS



note on soldering: remember to heat pad first (2-3seconds), then add solder, then continue to heat (1-2seconds)

Checkout the web-comic *soldering is easy* for more soldering advice

- start with the resistors, taking care place the correct value in the correct footprint (if you are unsure of the value can use an online resistor calculator) , direction does not matter. Place a few resistors in (as many as you are comfortable with) then solder and trim legs

- next lets do capacitors: 0.1u will say 104, while 1uf will say 105 on them - place them all and solder and trim.

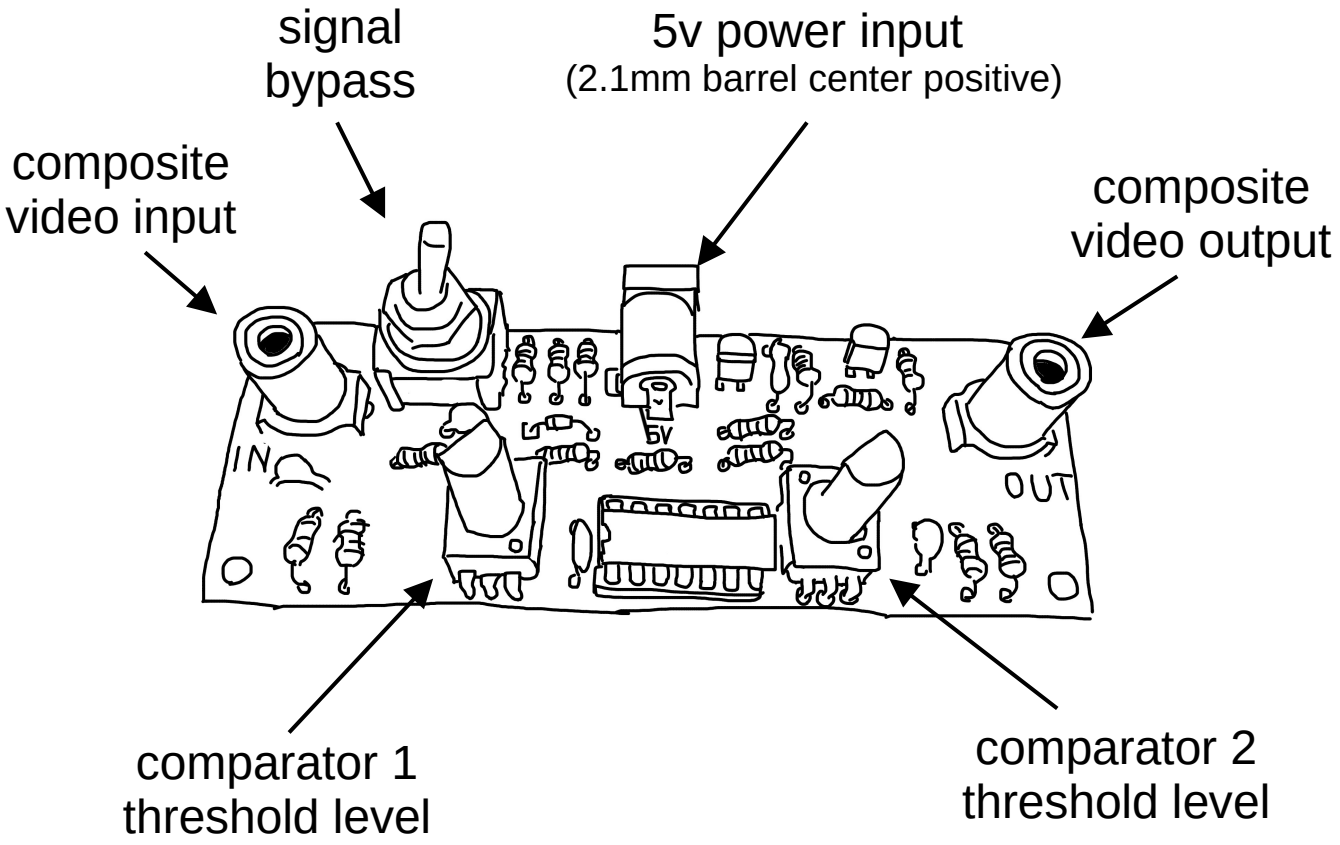
- now lets place diodes and transistors. take note of the direction on the diode - black bar on component matching black bar on footprint. Transistor values are printed on thembe sure not to mix them up ! be careful when soldering the to92 parts the pads are very close - this is the hardest part - i soldered the outer legs first, trimmed these and then soldered inner.

- now lets do the ic/socket -> make sure the direction is correct! place in and fold two corner pins to hold in place, then solder all pins. you can place the ic in now too.

- finally lets place the control parts, starting with the power jack (can use something under the board to balance it while you solder), next place the rca jacks and pots. be generous with the solder here -> this is to strengthen the mechanical connections as well as making electrical ones

See operating instructions page for setup and testing

OPERATING INSTRUCTIONS



To set up using the circuit plug an active video source into *composite video input* and a display into *composite video output* (test input/outputs by toggling signal bypass switch first to ensure they are working as expected)

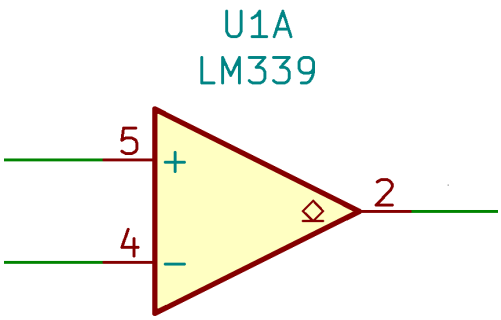
Next plug in a 5v center-positive power supply into the 2.1mm barrel jack connector – I like to use a usb wall charger for this – and toggle off the bypass

Adjusting the level knobs should change the resulting image – the thresholds control which brightness levels result in white black or gray regions.

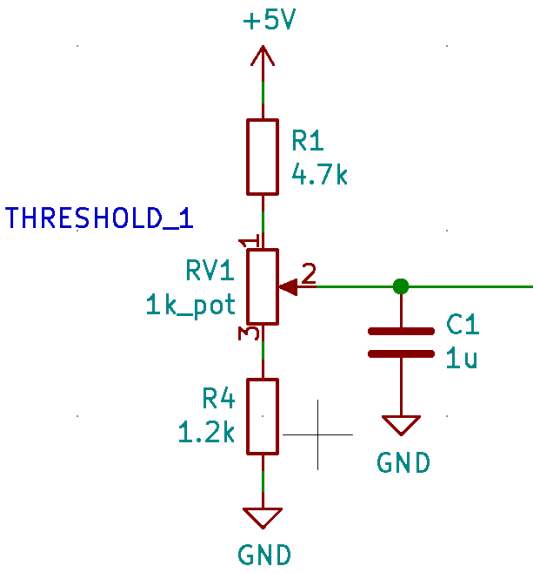
HOW THE CIRCUIT WORKS

Watch the youtube videos *Lesson 1 – Comparators* and *Lesson 2 – Clamping* by Rob Schafer for full explanation. See full schematics on the project page.

This circuit works by using multiple stages of an **LM339 - Quad Differential Comparator** ic.



A comparator stage *compares* the two voltages on its input (plus and minus) and outputs *high* if plus > minus, *low* if plus < minus. Since we power the ic with +5v, in this case *high* is an output of +5v and low is an output of 0v

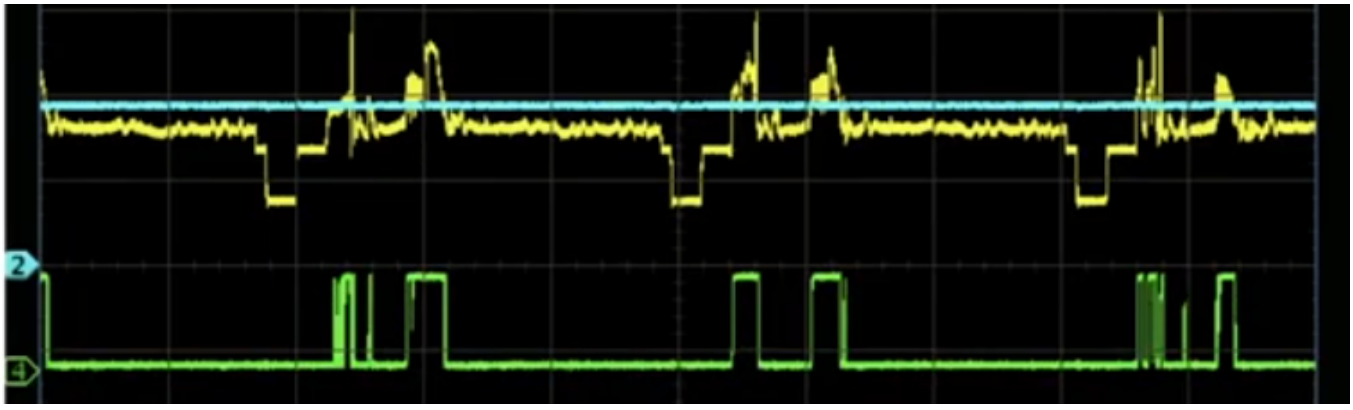


comparator plus input is connected to the analog video signal (where higher voltage corresponds to a brighter image)

The minus input is connected to a reference voltage which can be set by turning a potentiometer. varying the pot adjusts the resistance in this voltage divider configuration which in turn varies the voltage supplied as reference

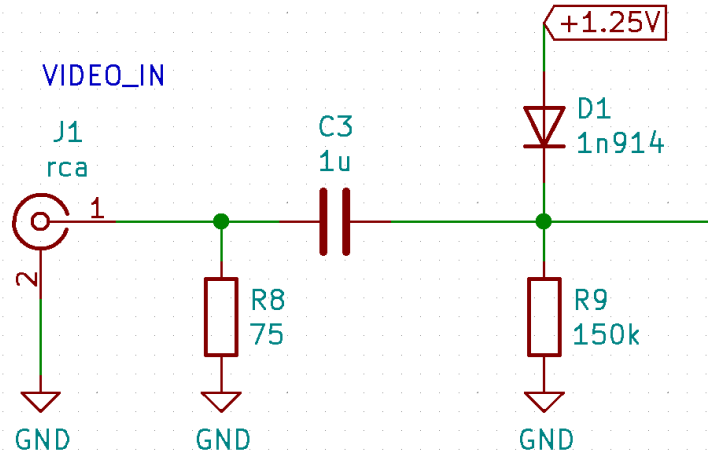
The result of this effect is an image that is all white for regions of the original image above a given brightness threshold level, and all black for the regions below this level. Changing this threshold changes which parts of the image are set to black vs white.

Here is a scoped example of an original signal (top) with threshold and the resulting signal (bottom)



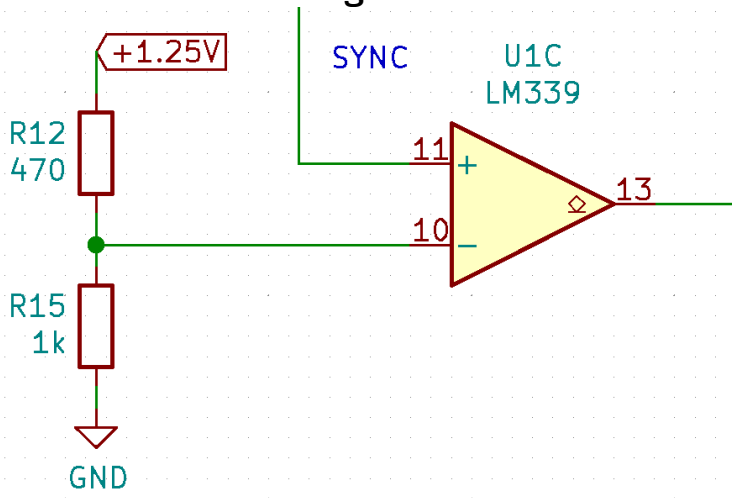
HOW THE CIRCUIT WORKS CONTINUED

Before reaching the comparators, the incoming video signal needs to be SOFT CLAMPED – this is done using a capacitor, diode and a 1.25v rail that was obtained with a LM317 voltage regulator.



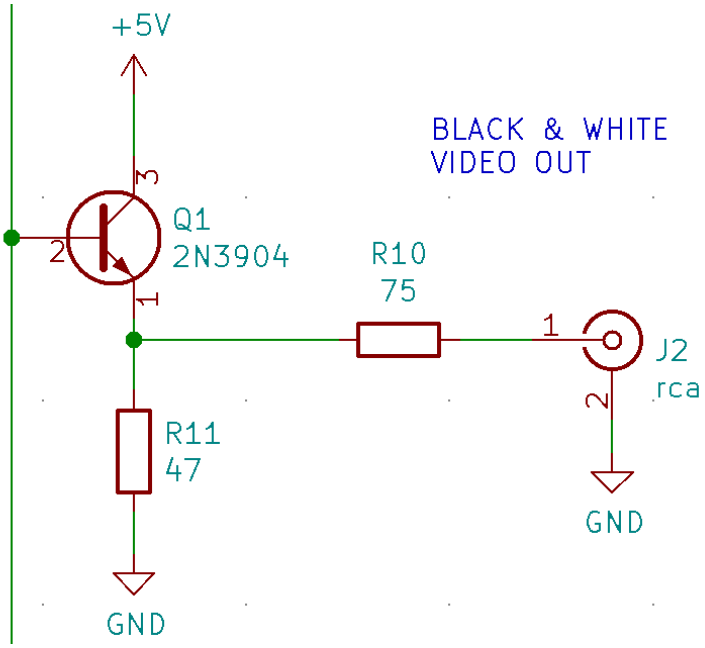
A composite video signal tends to squash up when the image is bright and spread out when it is darker.

For the comparator reference voltages to be consistence we need to correct for this behavior by *clamping* the signal to a fixed voltage level



A third comparator stage with a fixed reference voltage is used to 'pick off' the sync pulse of the original signal.

The output from these three comparator stages are scaled and combined to create a new composite video signal with the desired effect



Composite video encodes color as a *sub-carrier* frequency over the signal.

This circuit is designed for use with gray-scale video input where no sub-carrier is present, although it does still work with color input – usually ignoring the sub-carrier, although occasionally there are some artifacts generated by this. This is more common with NTSC than with PAL

glitch artifacts are also created when the comparator thresholds are set below the *black-level* of the video signal, causing the signal to lose sync.

CREDITS AND MORE INFO

This circuit is distributed through UNDERSCORES – open video hardware label – visit underscores.shop for more info

The pcb was designed using KICAD , this booklet was created in LibreOffice Draw

Everything from gerbers, cad files, panels and documentation is freely available online and distributed under CC-BY-SA / open-source licenses – help us contribute to the commons !

Ask any questions or start discussions related to this project on the *scanlines.xyz* forum – an online community space dedicated to diy av / electronic media art

You can contact me directly at *tim (at) cyberboy666 (dot) com*
Please get in touch if you are interested in hosting a workshop !

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underscores.shop

KiCad
DESIGNED WITH

Thanks to Rob Schafer for sharing your designs and knowledge. to Bastien Lavaud for circuit advice, always. To Guergana Tzatchkova for booklet design inspiration. To Ben Caldwell for project advice. To everyone who has or will contribute ♥♥♥