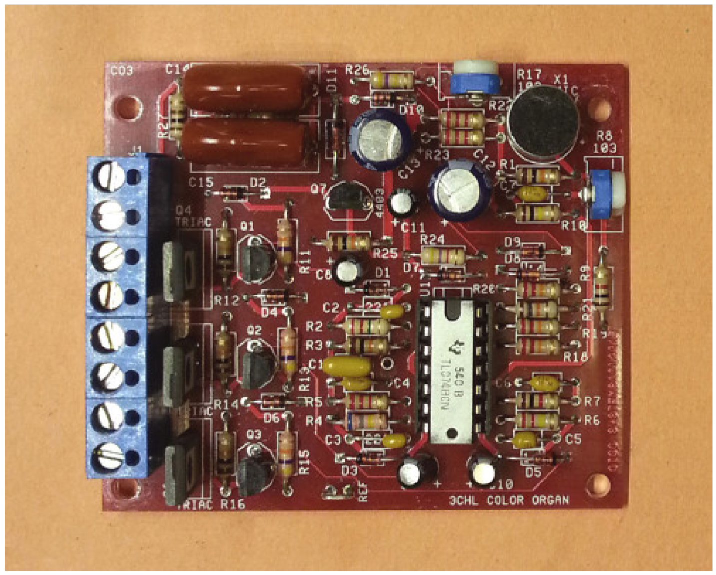
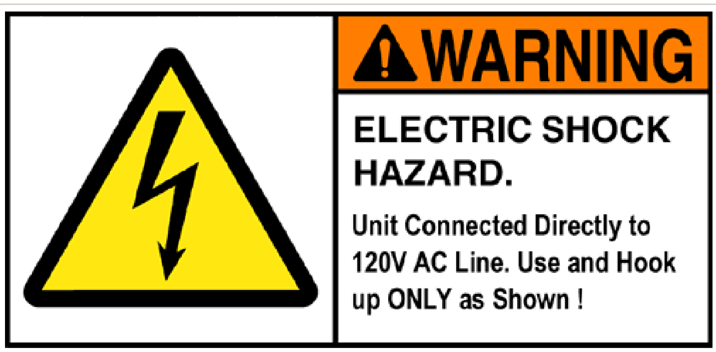
3 Channel Color Organ Kit



Thank for your interest in this kit. This is a traditional color organ, in the sense that it responds to 3 different regions of the sound spectrum, and illuminates three different light groups (channels) accordingly. It is also traditional, in that its designed to illuminate 120VAC incandescent lamps, as opposed to LEDs. LED brightness has improved dramatically, since ~1994, so the need for this circuit is really not needed, and is only for those who like to venture into the old ways.

Kits are available at my eBay Store – Tortugascuba.



The circuit is connected directly to the high voltage (120VAC) AC line so care must be taken when handling this circuit. It should ultimately be inside a proper enclosure to prevent it from being a shock and fire hazard.

The circuit, though, is an improvement on those that commonly came into use back in the 60's thru 70's. Those used mostly SCRs, that only pass half the AC sine wave. They also had no phase control, and used raw statistics, of the audio, to roughly adjust the brightness. It was a pure crap shoot !

Why a Crap Shoot !?

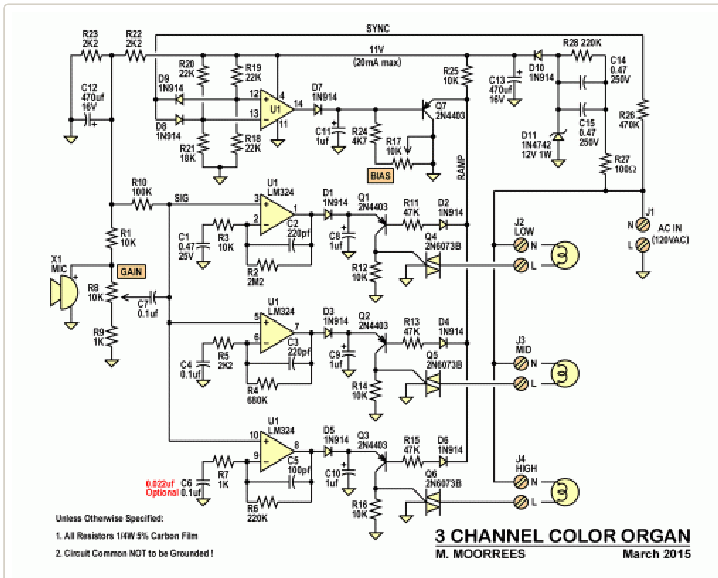
Its based on how both SCRs and TRIACs work. These devices are either ON or OFF. They DO NOT have a "middle" linear zone, were they only partially conduct, that transistors (and old vacuum tubes) have. There was a tube version of the SCR. It was called a thyratron, and it was not in a vacuum, but had a gas fill. When the audio, in the older circuits, was of adequate amplitude, it would turn ON an SCR. Where in the cycle, was purely arbitrary, and random. For low levels, it would kick the SCR ON for a few cycles, over any period of time. For high levels, it would turn ON more cycles, over the same time period.

The result, was some crude control of brightness. To properly control a [thyristor](#) (SCRs & TRIACs), the device must be turned ON, at a controlled, and repeatable, point within each AC cycle (or half cycle, for a TRIAC).

This circuit uses the audio amplitude to adjust the phase of the turn-ON, to ultimately adjust the brightness. You can actually set, the minimum brightness, when quiet, (Bias) to just make the lamp filament barely glow. Try this with the old circuits. It can't be done with those ! This circuit also uses TRIACs, and not SCRs. A TRIAC controls both halves, of an AC sine wave, for greater brightness.

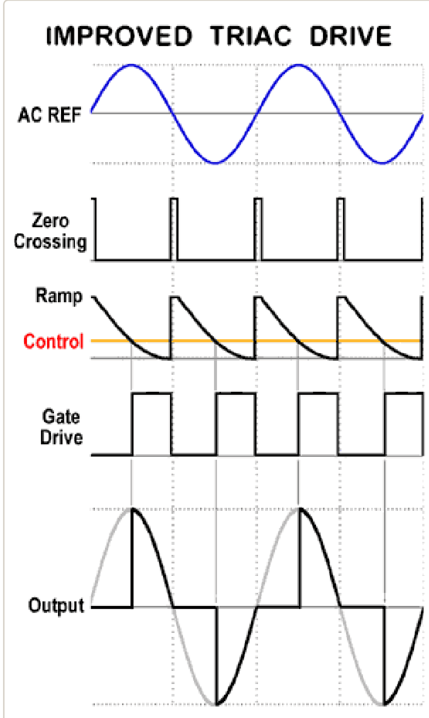
Since thyristors are either ON or OFF, all the power goes to the load (lamp), and none (or very little) is dissipated in the device (TRIAC), so they do not get hot, and do not need a heat sink. In most cases. Being only completely ON or OFF is also *part* of the magic of switch-mode power supplies, which are extremely efficient.

Below is the schematic, of the circuit *(Click on drawing to enlarge)*:



This circuit, gets the audio, directly from the surroundings, thru a microphone. This can be viewed as a safety feature, as it does not connect to any audio source. Many older circuits used an isolating audio transformer. This method only works, if that transformer is rated to handle the full AC voltage between primary and secondary. Most small low cost audio transformers, now, do not meet that specification. Many didn't meet it back then, either, and many a stereo went up in smoke, because of it.

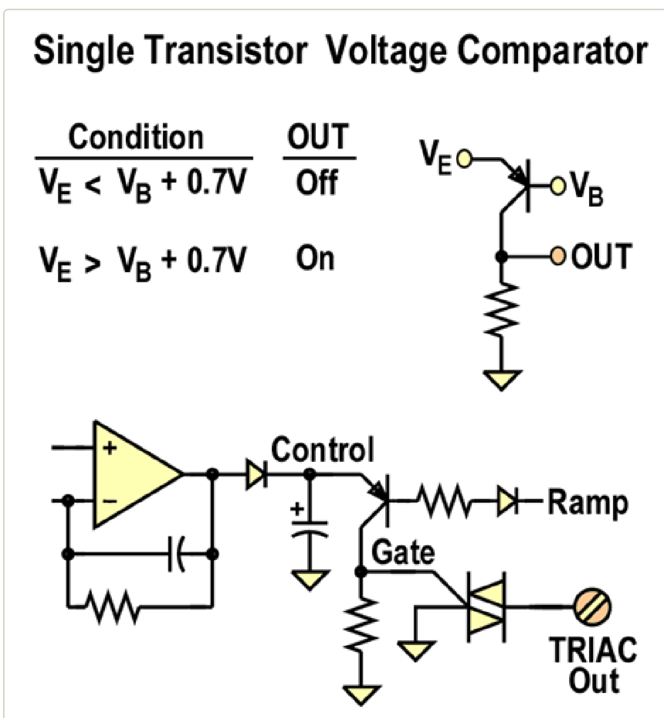
The audio, in this circuit, then gets amplified by 3 of the 4 stages, of a common quad op-amp IC. Each of these three stages are tuned to a certain portion of the audio spectrum. One for low frequency bass notes, one for high frequency treble notes, and the third in the middle. These channels overlap, because the filtering is only 1st order. Each of the amplified audio signals are then passed thru a diode and capacitor, which results in only the envelope of their amplitude from passing further. Those three envelopes are used to control each channels brightness.



The brightness is controlled by turning on the TRIAC's gate at a certain time relative to the AC power's "zero crossing", or phase. The earlier, the gate is turned ON, the brighter the lamp. The drawing, above, shows how this is done.

The "zero" reference, is set, using the 4th op-amp stage, wired as a [zero-crossing detector](). When the AC is near zero, the comparator's two voltage dividers, are set so the output is high. When the AC is too positive, the signal passing thru D8, pulls the inverting input (-) of the comparator greater than the non-inverting (+), input, dropping the output low. When the AC is too negative, the signal passing thru D9, drags the non-inverting (+) input lower than the inverting (-) input, again causing a low output. The output is only high during a small region when the AC is near zero.

The zero crossing is used to reset a negative going ramp, who's time constant is adjusted by the *bias* trimpot, R17. This also has the effect of adjusting its amplitude. The ramp is fed to the three PNP transistors' bases, that actually drive the TRIACs' gates. These transistors act as simple [voltage comparators](). When the *control* voltage (for each channel), which is tied to the emitter, is higher than the ramp voltage, the transistor conducts, and passes current into its respective TRIAC gate. The higher the *control* voltage, the earlier, in the cycle, the TRIAC is turned ON.



A resistor is stuck in the base leg of each transistor, to limit the base current. A diode is also inserted, to block reverse current. Transistor base emitter reverse voltage specs are usually 5 to 6V max. Also any reverse voltage can permanently make any transistor noisier.

There are limitations to using a transistor as a comparator. The compare voltage is offset by 0.7V, which varies some with temperature. The output tracks the emitter voltage, and all current that is delivered to the output, comes from the emitter side. In this case that's fine. Once the TRIAC is turned ON, no more gate current is needed. There is no conduction, in the emitter-collector path until the "threshold", it reached, then that current is dumped into the gate. Very similar to the function of an old fashion DIAC. Except here, the "threshold" varies with base voltage.

Below is the Bill of Materials, of items, that come with the kit:

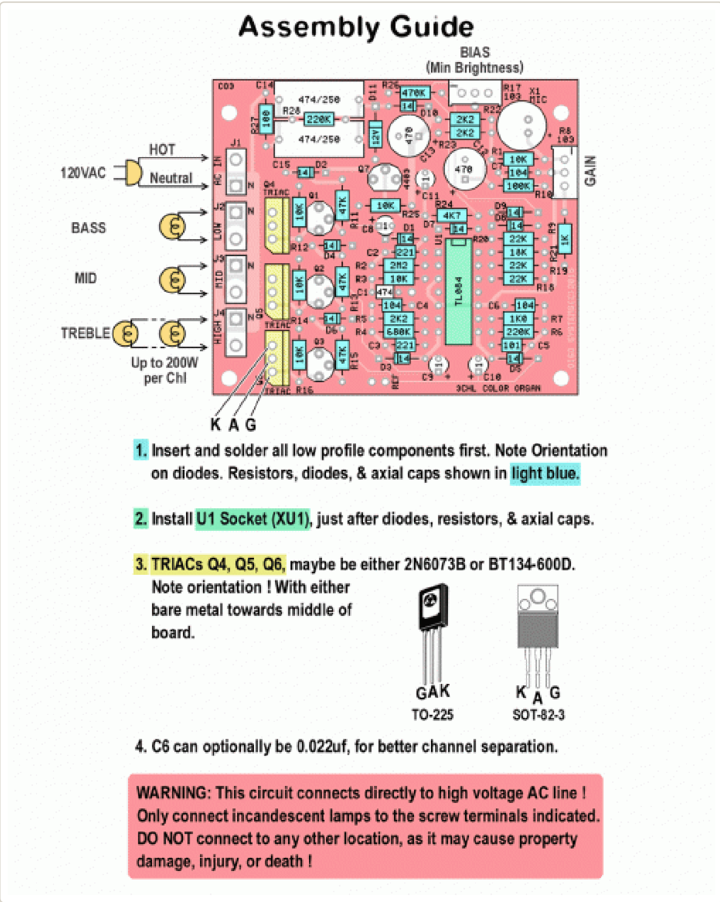
Bill of Materials:

Ref Designator	Qty	Description	Mfr Part No.	Markings
C5	1	100pf, 50V, 10% Ceramic, Axial	Generic 100pf MLCC Axial	101
C2, C3	2	220pf, 50V, 10% Ceramic, Axial	Generic 220pf MLCC Axial	221
C4, C6, C7	3	0.1uf, 50V, 20% Ceramic, Axial	Generic 0.1uf MLCC Axial	104
C6 Optional		0.022uf, 50V, 20% Ceramic	Generic 0.022uf Ceramic	223
C1	1	0.47uf, 50V, 20% Ceramic, 0.3"LS	Generic 0.47uf MLCC Radial	474
C14, C15	2	0.47uf, 250V, Plastic Film, Radial	Panasonic ECQ-E2474KF	474
C8, C9, C10, C11	4	1.0uf, 50V Al Electrolytic, Radial	Panasonic ECE-A1HKS010I	
C12, C13	2	470uf, 16V Al Electrolytic, Radial	Panasonic ECA-1CM471	
R27	1	100Ω, 1/4W, 5% Carbon Film	Generic 1/4W 5% Carbon Film	
R7, R9	2	1.0K, 1/4W, 5% Carbon Film (1K)	Generic 1/4W 5% Carbon Film	
R5, R22, R23	3	2.2K, 1/4W, 5% Carbon Film (2K2)	Generic 1/4W 5% Carbon Film	
R24	1	4.7K, 1/4W, 5% Carbon Film (4K7)	Generic 1/4W 5% Carbon Film	
R1, R3, R12, R14, R16, R25	6	10K, 1/4W, 5% Carbon Film	Generic 1/4W 5% Carbon Film	
R21	1	18K, 1/4W, 5% Carbon Film	Generic 1/4W 5% Carbon Film	
R18, R19, R20	3	22K, 1/4W, 5% Carbon Film	Generic 1/4W 5% Carbon Film	
R11, R13, R15	3	47K, 1/4W, 5% Carbon Film	Generic 1/4W 5% Carbon Film	
R10	1	100K, 1/4W, 5% Carbon Film	Generic 1/4W 5% Carbon Film	
R6, R28	2	220K, 1/4W, 5% Carbon Film	Generic 1/4W 5% Carbon Film	
R26	1	470K, 1/4W, 5% Carbon Film	Generic 1/4W 5% Carbon Film	
R4	1	680K, 1/4W, 5% Carbon Film	Generic 1/4W 5% Carbon Film	
R2	1	2.2M, 1/4W, 5% Carbon Film (2M2)	Generic 1/4W 5% Carbon Film	
R8, R17	2	10K, Side Adj Trimpot	Piher (Mouser) N6-S25T0C-103	
D1 - D10	10	Small Signal Silicon Diode, DO-35	Generic 1N4148, or 1N914	Small Glass
D11	1	12V, 1W, 5% Zener Diode, DO-41	Generic 1N4742A	Large Glass
Q1, Q2, Q3, Q7	4	2N4403 Gen Purpose PNP, TO-92	Generic 2N4403	
Q4, Q5, Q6	3	400PRV, 2A Logic TRIAC	NXP BT134-600D, or ON 2N6073B	
U1	1	Quad Op-Amp 14-DIP pkg	Generic TL084, or LF347	
X1	1	Electret Mic, 3/8" Dia.	Radio Shack 270-090, CUI CMA-6542PF	
XU1	1	14 DIP Socket	Generic 14-DIP Socket	
J1 - J4	4	2-Pin 0.2" Terminal Block	5mm Screw Terminal Block, 2-pin	
PCB	1	PCB	Oigo OIG-CO3	

Suppliers: mouser.com, digikey.com, Radioshack.com

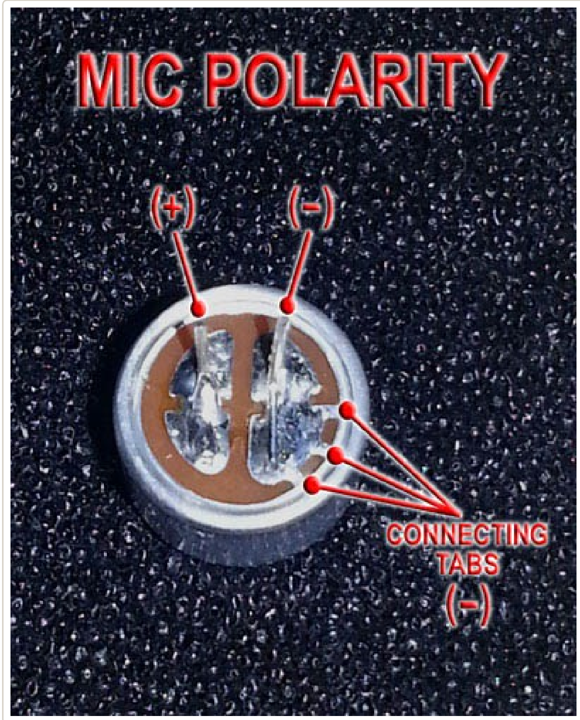
Be sure to insert the proper component into the proper location, and in the proper orientation, where applicable. There is an 18K resistor (R21), with a second band which is gray. Take care, since it can easily be confused with the black band on the 10K resistors.

Note: two capacitors have been provided for C6. One is an 0.1uf axial, while the other is a 0.022uf ceramic disk. Its up to you, which you want to install in the circuit.

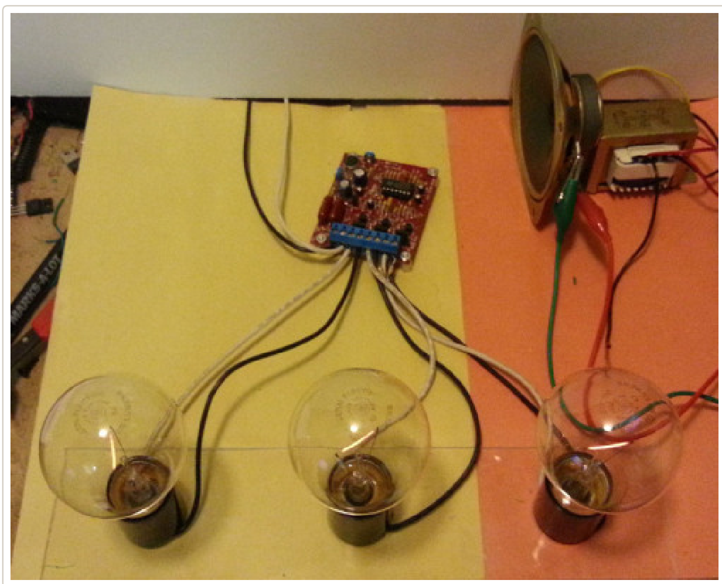


You will find that J1 thru J4 come in one 8-pin block. That block is actually formed from 4 2-pin interlocking terminal blocks.

Microphone polarity: make sure its installed properly.

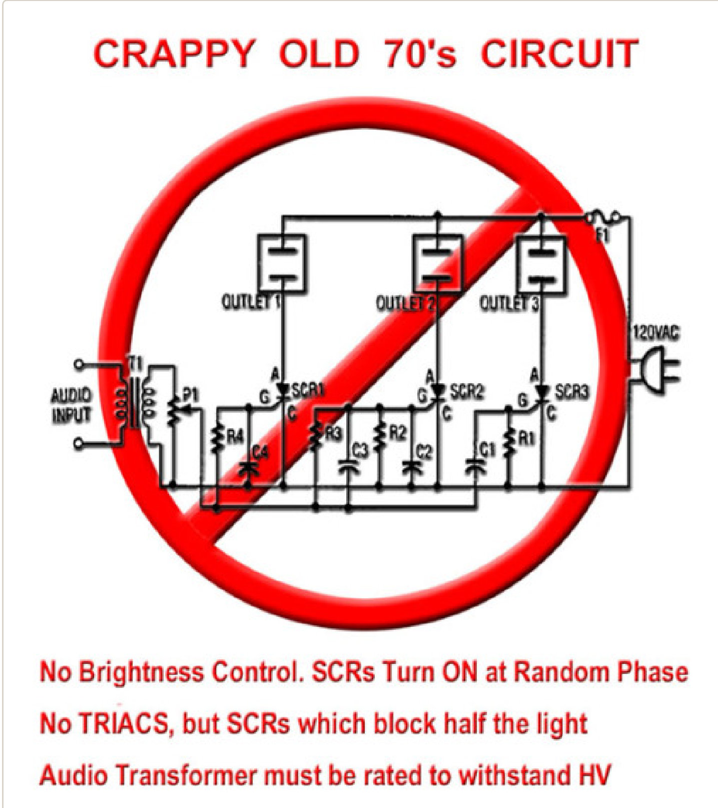


Below is the board hooked up to 3 clear 60W light bulbs.*(click on photo to see demo video)*:



Warning:

This unit should only be used to drive lamp loads. Mostly incandescent lamps, with a combined rating (per channel) not exceeding 200W. It should also drive 120V rated LED Christmas lite strings, since those mostly just have a simple resistor current limiter. Only drive individual 120V LED lamps, if they explicitly allow dimmer use. Halogens are fine, too, if they are 120V and under 200W. NEVER use with fluorescent lamps, or other lamp technologies that are not listed here. No motors, either. This unit uses Logic TRIACs, which have more trouble with inductive loads, than most variations of TRIACs.



Auxiliary Info:

TRIAC Datasheets: These devices have been found to work properly in this kit. Any of these may be found in the kit, as shipped.

2N6073 – Both A and B suffix types will work. B type is more sensitive. *(97KB)*

BT134-600D – NXP, formerly Phillips Semiconductor. *(170KB)*

BT134-600**E** – Less sensitive than BT134-600**D**, but works in this circuit. *(169KB)*

L4004L3 – Littelfuse, formerly Teccor. *(911KB)*

Go visit my Mood Lite Kit page for the single channel versions.

End

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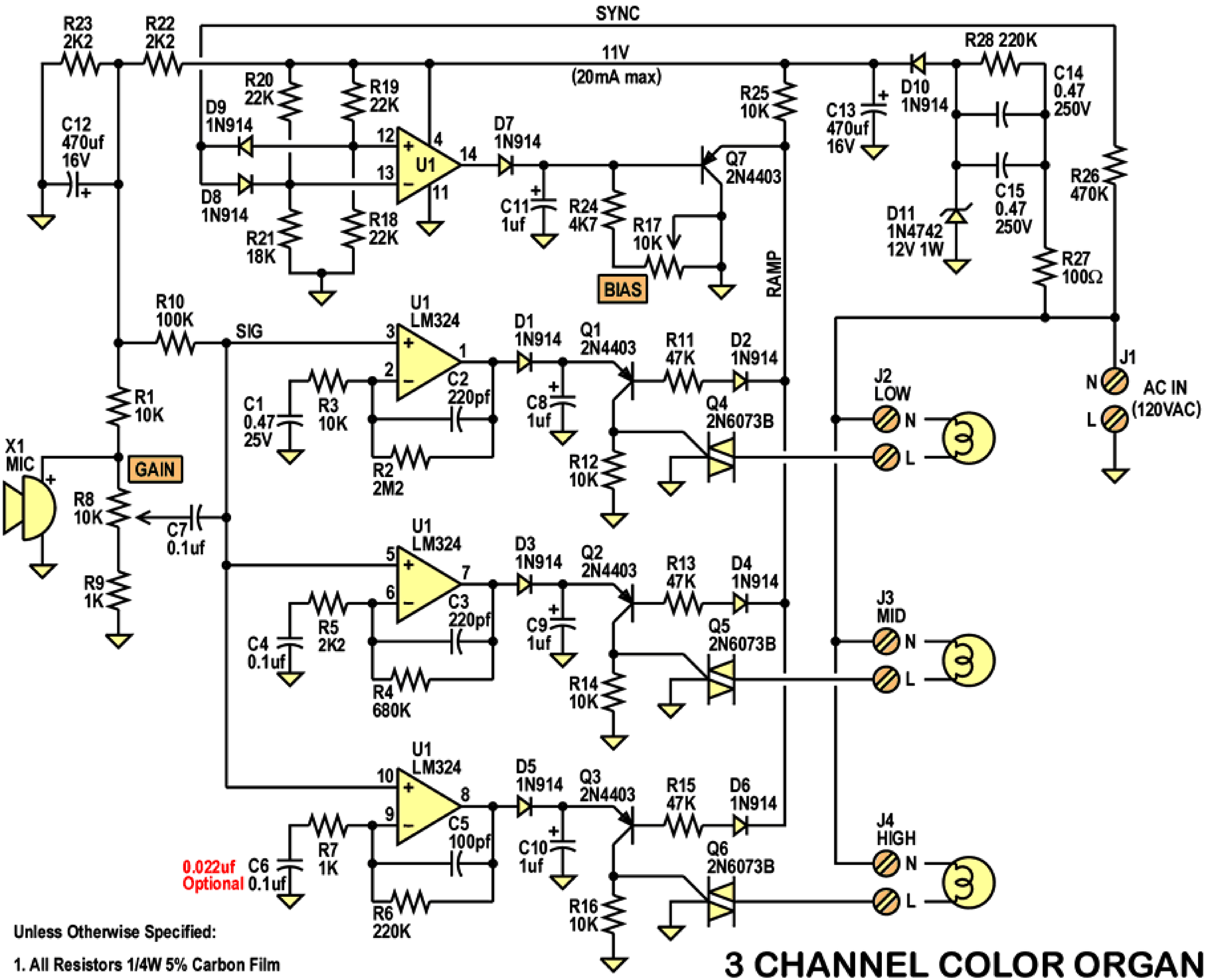

Unless Otherwise Specified:

1. All Resistors 1/4W 5% Carbon Film

2. Circuit Common NOT to be Grounded !

3 CHANNEL COLOR ORGAN

M. MOORREES March 2015

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U1	1	Quad Op-Amp 14-DIP pkg	Generic TL084, or LF347	
X1	1	Electret Mic, 3/8" Dia.	Radio Shack 270-090, CUI CMA-6542PF	
XU1	1	14 DIP Socket	Generic 14-DIP Socket	
J1 - J4	4	2-Pin 0.2" Terminal Block	5mm Screw Terminal Block, 2-pin	
PCB	1	PCB	Oigo OIG-CO3	

Suppliers: mouser.com, digikey.com, Radioshack.com