A Power Transformer Substitution for the Bally/Astrocade Computer System

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MCM Design
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The time may come when, as a result of some failure on the Bally/Astrocade motherboard, the black Bally power transformer (xfmr), that plugs into a 120vac outlet, will overheat and burn out or the aging xfmr might just simply stop working. Where would you find a replacement? Good question. You may be forced to buy an entire Bally/Astrocade computer system on Ebay. If you have some experience in electronics, you may have another option. You could build a substitute pwr xfmr.

Building a pwr xfmr substitution has already been documented by me in the "Arcadian" newsletter, 1986, pages 92, 93 and 91, which is archived on BallyAlley.com. This new 2018 article is an update on that past article.

Figure "A" below shows what's inside the Bally pwr xfmr plastic housing. There is one primary winding and 3 secondary windings wired in series. Note the two end windings are identically rated 85mA@11.5vac rms. The xfmr ratings are indicated on its plastic housing. Essentially, you could substitute 3 pwr xfmrs having sec voltages close to the rated Bally xfmr voltages with the capability of putting out at least the rated sec current. You could then wire the 3 primary windings in parallel and the 3 secondary windings in series as shown in figure "B" below. For the end sec voltages, 12.6vac would probably be the maximum. Lower than 12.6vac would be preferred. For the center sec winding, 6.3vac is typical and works great. This scheme will give you a larger, bulkier pwr xfmr, but the scheme does work.

It just so happens, that Jameco Electronics, at this time, stocks two xfmrs that are well suited for this application. I hard wired these 2 xfmrs and tested the scheme extensively. The scheme runs great. An added bonus is that the menu appears immediately at power on. Pressing the reset button is not necessary to clear the screen and display the menu. The documentation for the Jameco xfmr substitution scheme, including photos, is posted below.

USING 2 JAMECO XFMRs AS THE SUBSTITUTION

Jameco stocks 2 split-bobbin power transformers, I will designate as xfmr A and xfmr B. Each xfmr is actually a "combo" containing 2 identical xfmrs side by side. Xfmr A, Jameco part#102593, has 2 identical secondaries rated 12vac@0.5A rms. Each of these sec is used as the end sec winding in the pwr xfmr substitution. Xfmr B, Jameco part#2231152, also has 2 identical sec rated 6.3vac@0.5A. These 2 sec are wired in parallel to each other and are used as the center sec winding in the pwr xfmr substitution, yielding a parallel output of 6.3vac@1.0A rms. Jameco provides data sheets for both xfmrs A and B. Figure "C" below shows how xfmrs A and B are wired for the pwr xfmr sub. This scheme looks complex, but can be broken down as 3 xfmrs. Use the figure "A" drawing as an "end result" guide and also refer to the "bottom view" photo as another guide when wiring this sub. Note the scheme in figure "C" is a variation of the scheme mentioned above for figure "B".

TEST RESULTS FOR THE JAMECO SUBSTITUTION

1. Voltage readings were taken across the sec windings for both a Bally xfmr and the Jameco sub. Neither xfmr was connected to the motherboard (no load test).

Bally xfmr (no Load)	wht-grn	13.0vac		Jameco sub (no load)	wht-grn	15.5vac
	grn-red	10.5vac			grn-red	9.3vac
	red-blk	13.0vac			red-blk	15.5vac

2.Voltage readings were taken with the indicated conditions:

A. Voltage across cap C6, pwr xfmr on, motherboard pwr switch off.

Bally xfmr VC6=15.5vdc (note: above 10vdc cap rating)
Jameco sub VC6=12.5vdc (also above 10vdc cap rating)

B. Voltage readings were taken across the indicated caps with both the pwr xfmr and motherboard power switch on.

	Bally xfmr	Jameco sub
10,000uf	VC6=10vdc	VC6=7.2vdc
2500uf	VC1=24vdc	VC1=24.5vdc
100uf	VC10=-15.5vdc	VC10=-20.5vdc (note: above 16vdc cap rating)

C. Voltage readings were taken across the indicated caps after running 100 rounds of Checkmate.

Bally xfmr	Jameco sub
VC6=9.5vdc	VC6=7.1vdc
VC1=23.0vdc	VC1=24.5vdc
VC10=-15.0vdc	VC10=-20.5vdc (still above 16vdc cap rating)

D. Heat dissipation check during Checkmate run.

The above tests were performed with top of console and top rf shielding removed. As expected, after only a few minutes of operation, the 2 voltage regulator heat sinks and custom data chip heat sink were very hot to the touch. So, a small neighboring fan was turned on to keep the motherboard area cooler. This is standard procedure for MCM Design running any Bally/ Astrocade motherboard.

E. Voltage readings were taken across the pwr xfmr secondary windings after 100 rounds of Checkmate and motherboard still running.

	Bally xfmr	Jameco sub
wht-grn	11.0vac	14.5vac
grn-red	9.1vac	6.5vac
red-blk	11.0vac	14.5vac

F. Voltage reading across cap C6 after Checkmate run with pwr xfmr still plugged in (on) and motherboard power switch turned off.

	Bally xfmr	Jameco sub
VC6	15.5vdc (above 10v cap rating)	12.5vdc (also above 10v cap rating)

G. Voltage readings were taken for all 4 dc power supplies.

dc power supply	Bally xfmr	Jameco sub
+5vdc	5.3vdc	5.4vdc
+10vdc	10.0vdc	10.0vdc
+12vdc	12.0vdc	12.5vdc
-5vdc	-5.3vdc	-5.4vdc

TEST COMMENTS

As a precaution, caps C6, C1 and C10 were replaced, prior to testing, with caps 10,000uf 16V, 2200uf 35V and 100uf 35V respectively.

Test 1. The no load sec voltage on the Bally xfmr center winding was a bit higher than expected, suggesting the output voltage tolerance on these Bally pwr xfmrs is high, but acceptable.

The no load output sec voltages on the Jameco sub end windings were actually lower than expected, which in this case is preferable.

Test 2. A. and F. Some motherboards have 10,000uf C6 caps rated 16V. Others are rated only 10V, which is a poor choice when a Bally pwr xfmr is energized (on) and the motherboard power switch is off. This issue was discussed in a past article (see note 1 below).

Test 2. B. and C. When using the Jameco sub, the 100uf cap C10 must be replaced with a cap having a higher voltage rating of at least 35wvdc.

When I ran the above tests, the Bally xfmr and Jameco sub were plugged into a power strip. I accidently came up with the idea to turn the motherboard power switch "on" and leave it in that position. Then, use the power strip to turn on (or off) the pwr xfmr and motherboard power simultaneously. This is my revised recommendation now (for my first recommendation, see note 1 below), for two reasons:

1. Using a power strip to power on a Bally/Astrocade computer seems to prevent the voltage across the 10,000uf cap C6 from exceeding 10V. If this cap is rated 16V on your motherboard, then this statement is irrelevant.

2. Using a power strip to power off a Bally/Astrocade computer will quickly discharge the cap C6 to a more safe voltage level of 1.4vdc or less.

You can check out this issue for yourself by connecting a voltmeter across cap C6 and powering on and off your Bally/Astrocade. Make sure your power strip is "off" before you plug in the Bally power xfmr into the strip.

HARD WIRE A FUSED 120VAC RECEPTACLE NEXT TO YOUR JAMECO PWR XFMR SUBSTITUTION

If you can get your hands on a small 120vac receptacle, mount it next to the Jameco sub and wire a fuse holder to this receptacle. You will then be able to plug in your Bally/Astrocade pwr xfmr and offer it some protection should the

motherboard fail with a short to ground. See photo below showing my small fused 120vac receptacle.

MOUNT OPTIONAL SOLDERLESS BREADBOARD

Another recommendation is to mount a quick connect breadboard next to the Jameco sub (see photo). By adding a few components to the breadboard like a fuse (optional), bridge rectifier, some caps and load resistor(s), you can desolder and check suspicious voltage regulators, transistor Q1 or high capacitance caps on the motherboard to see if they are operating correctly. Using this technique allows you to test specific Bally/Astrocade power supply components without powering on the motherboard and risking further damage. You can wire the ac inputs of the bridge rectifier to the two appropriate Jameco sub sec output lines (see "TEST CIRCUITS" below). Don't forget to disconnect the 4 wire color coded power connector from the motherboard when using the breadboard for testing.

PHOTOS AND WIRING RECOMMENDATIONS FOR THE JAMECO SUBSTITUTION

Photo 1 shows my version of a Bally power xfmr substitution using the two Jameco xfmrs A and B specified above along with a fused primary and the standard black 4 conductor Bally power cable wired to the substitution secondaries. Bottom left is the fused 120vac receptacle for use with a black Bally power xfmr. To the right of the Jameco xfmrs are 2 quick connect breadboards. You can solder 4 hook-up wires to the 4 output secondary voltage lines via the 4 contacts protruding through the top of the green hobby board, just to the right of the 2 Jameco xfmrs, and plug the other ends of the hook-up wire to the desired locations on the breadboard. You will need these 4 sec voltage lines for the 4 test circuits below.

Photo 4 shows the Jameco substitution to the left of the motherboard running Checkmate as a test demo as seen vaguely on my 19" Toshiba TV.

Photo 5 shows the xfmr hobby board flipped over to view its bottom and wiring to the primary fuse and standard black Bally 4 conductor power cable.

Photo 6 shows a closer view of the bottom of the xfmr board. The 2 Jameco xfmrs A and B are held in place by the 16 solder joints. All of the 16 xfmr pins are labeled. Refer also to the Jameco data sheets for these 2 xfmrs. Bus bar hook-up wire (#24awg, Jameco part#2098478) was used to connect to all 16 xfmr pins. Rather than cross wires, the bus wire was looped through the top of the xfmr board in 2 places: upper left and near upper right as viewed from the bottom. Six push-in micro-klip solder terminals (Jameco part#34147) were used to connect the two 120vac wires and 4-color coded secondary wires that connect to the Bally/Astrocade motherboard. These solder terminals protrude through the top of the xfmr board. Refer to my article mentioned above in the "Arcadian" for more info and drawings regarding the external wiring to the Jameco xfmr board.

Fuses- Use no greater than 1A fast acting fuses. Your local hardware store may stock 1/2A fuses. Jameco stocks a 250mA (0.25A) fuse part#69404. Use 1A fuses for troubleshooting a motherboard, because they're readily available at a

hardware store, then switch to a lower rated fuse for possible added protection when your motherboard is up and running perfectly.

TEST CIRCUITS

There are two benefits in building this substitute xfmr.

1. When troubleshooting a failed motherboard, you can use this substitute instead of risking damage to a Bally power xfmr that is not readily available for purchase.

2. When troubleshooting the power supply on the motherboard, you can disconnect the 4 conductor power cable from the motherboard and wire quick breadboarded test circuits to the substitute xfmr to test suspicious voltage regulators, transistor Q1 or high-capacitance caps that are in the motherboard power supply. This way, you can confirm the suspicious component is bad before replacing the component on the motherboard.

There are 4 test circuits below that can be used to test all 4 voltage regulators, power transistor Q1 and if you like, the various power supply capacitors.

TEST CIRCUIT 1

This circuit shown below can be used to test suspicious voltage regulators VR1 and VR2 and/or electrolytic cap C1. I just happen to have a 250 ohm 5W resistor I could use as the load resistor. Size your resistor to draw no more than say 100mA, which is more than what the motherboard power supply will draw. Note that the electrolytic cap C1 must be rated at least 35wvdc because that cap may see as high as 32v across it. Clip a heat sink on top of the voltage regulator or use 2 alligator clips.

TEST CIRCUIT 2

You can test the voltage regulator VR3 independent of transistor Q1. The two 5.1K resistors set the output of VR3 to 10vdc. This circuit was taken from the Fairchild uA78G data sheet. I used my 250 ohm 5W resistor as the regulator's test load. The same guide lines in TEST CIRCUIT 1 apply here also.

TEST CIRCUIT 3

This circuit is mainly for testing power transistor Q1, but it does utilize voltage regulator VR3. The circuit is not a real voltage regulator in the sense that you can vary the output load and expect the output voltage to remain at +5vdc. The circuit is strictly set up to determine if Q1, once desoldered from the motherboard, is actually working. Note that the bridge rectifier, in this case, is wired to the Jameco sub CENTER winding (grn-red). The resistive load is set at 10 ohms 10W drawing around 1/2A at nearly +5vdc. You can tweak the DC output by varying the base resistor RB. Increasing this resistor from 240 to 330 ohms will DECREASE the output voltage a little. When you desolder Q1 from

the motherboard, you will probably have to file down the solder on Q1's leads so you can insert it into the breadboard. Attach a couple of alligator clips to Q1's heat sink tab. If Q1 is working, it will heat up and the voltage base to emitter (b-e) will be around 0.7vdc. You don't really need cap's CB and CC. They are optional. This circuit is a variation of an application circuit shown on the Fairchild data sheet for the uA78G 4-terminal adjustable regulator.

TEST CIRCUIT 4

This circuit can test the -5v voltage regulator VR4. Note the polarity of the bridge rectifier is reversed. The bridge rectifier ac inputs are wired to either of the Jameco sub end windings (red and blk, wht and grn).

FINAL COMMENTS

The Jameco substitution xfmr detailed above works very well. However, the 100uf capacitor C10 on the motherboard must be replaced with a cap having a voltage rating of at least 35wvdc.

If you use a power strip to turn on/off your Bally/Astrocade, leaving the motherboard power switch always in the "on" position, then you can get by with the 10,000uf cap C6 rated only 10wvdc. But, it probably would be a good idea to replace the aging C1, C6, C10, and C8 electrolytic capacitors as a precaution.

If you are going to build this xfmr sub, find a small 120vac receptacle or modify an extension cord (or something) and mount that, along with a fuse holder, next to the Jameco sub so you can optionally plug and help protect your Bally pwr xfmr should you choose to use it.

NOTES

1. For more info, see my article "Troubleshooting The Power Supply In The Bally/Astrocade Home Computer System" archived on BallyAlley.com. It currently resides here:

http://www.ballyalley.com/faqs/faqs.html#TroubleshootingtheAstrocadePowerSupply

End of document
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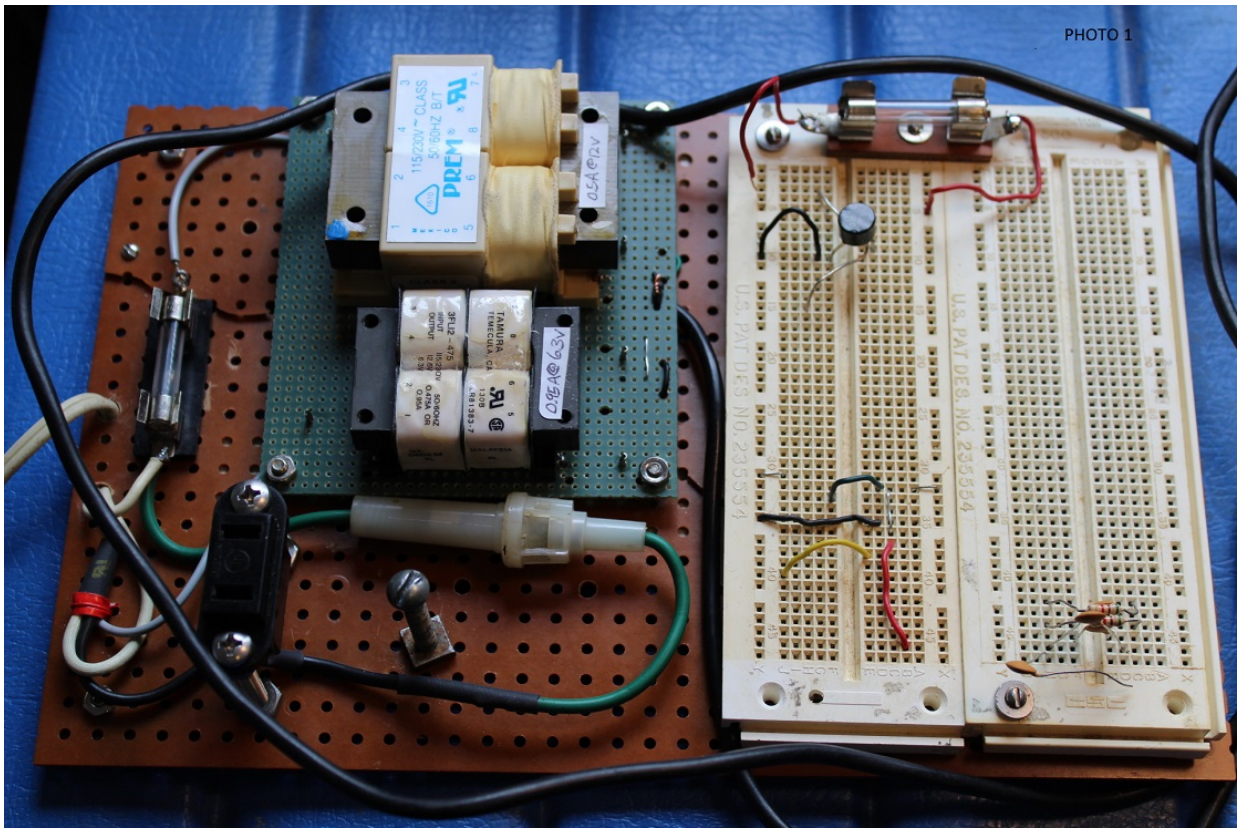


(Photo 1)

A Bally power xfmr substitution using the two Jameco xfmrs A and B specified above along with a fused primary and the standard black 4 conductor Bally power cable wired to the substitution secondaries.

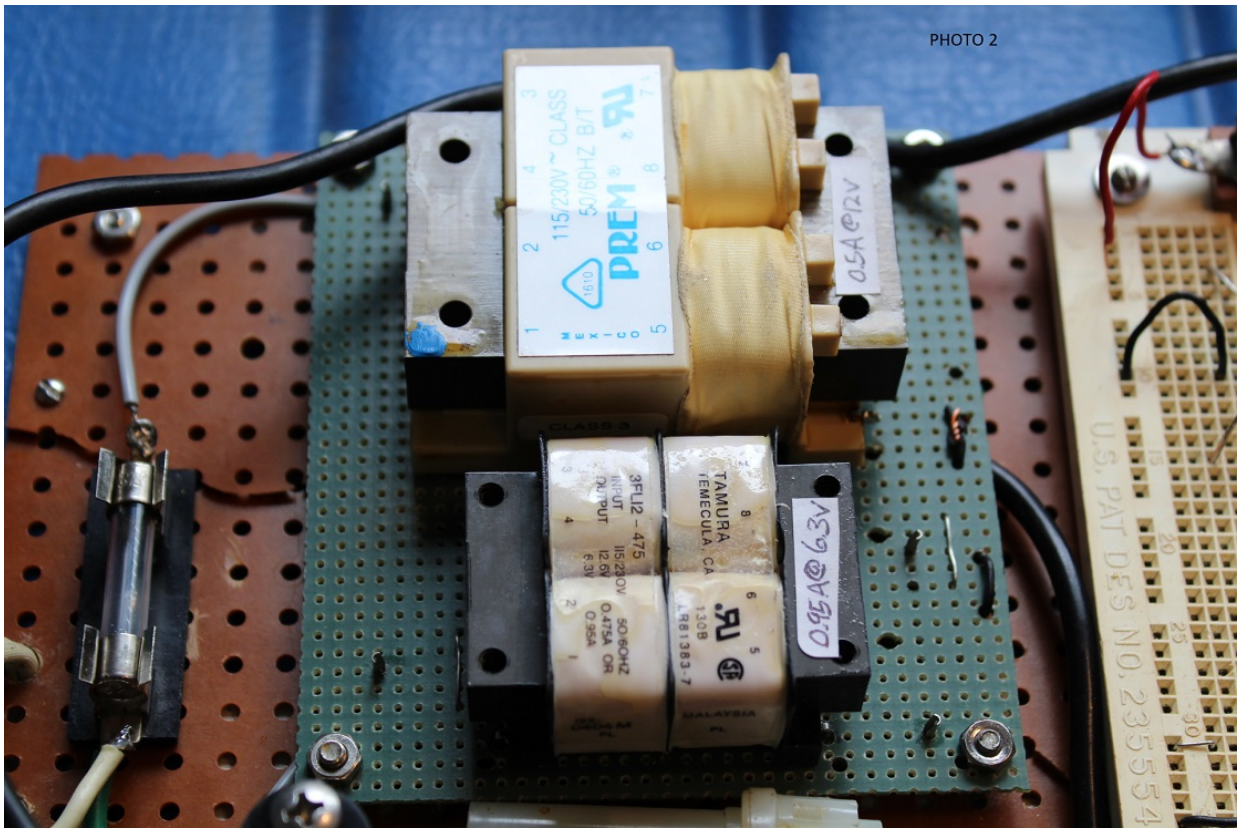
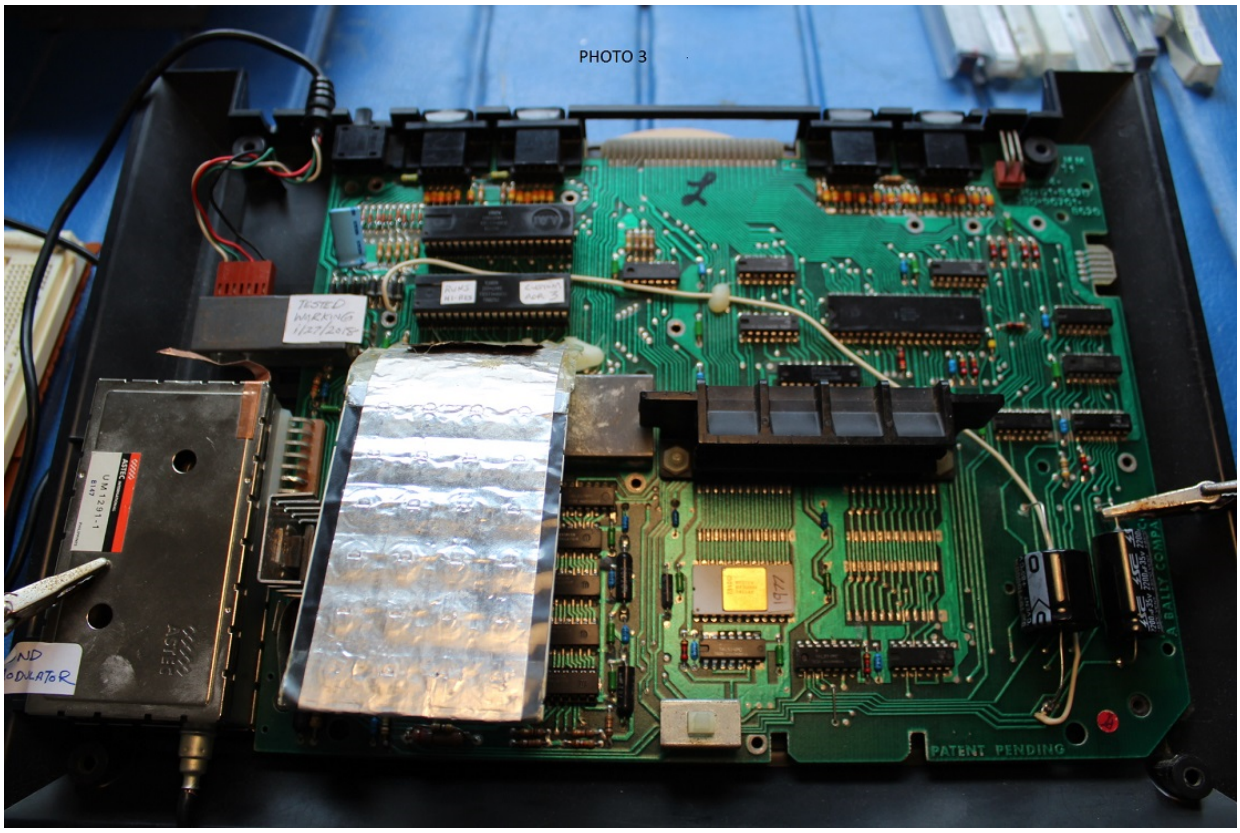
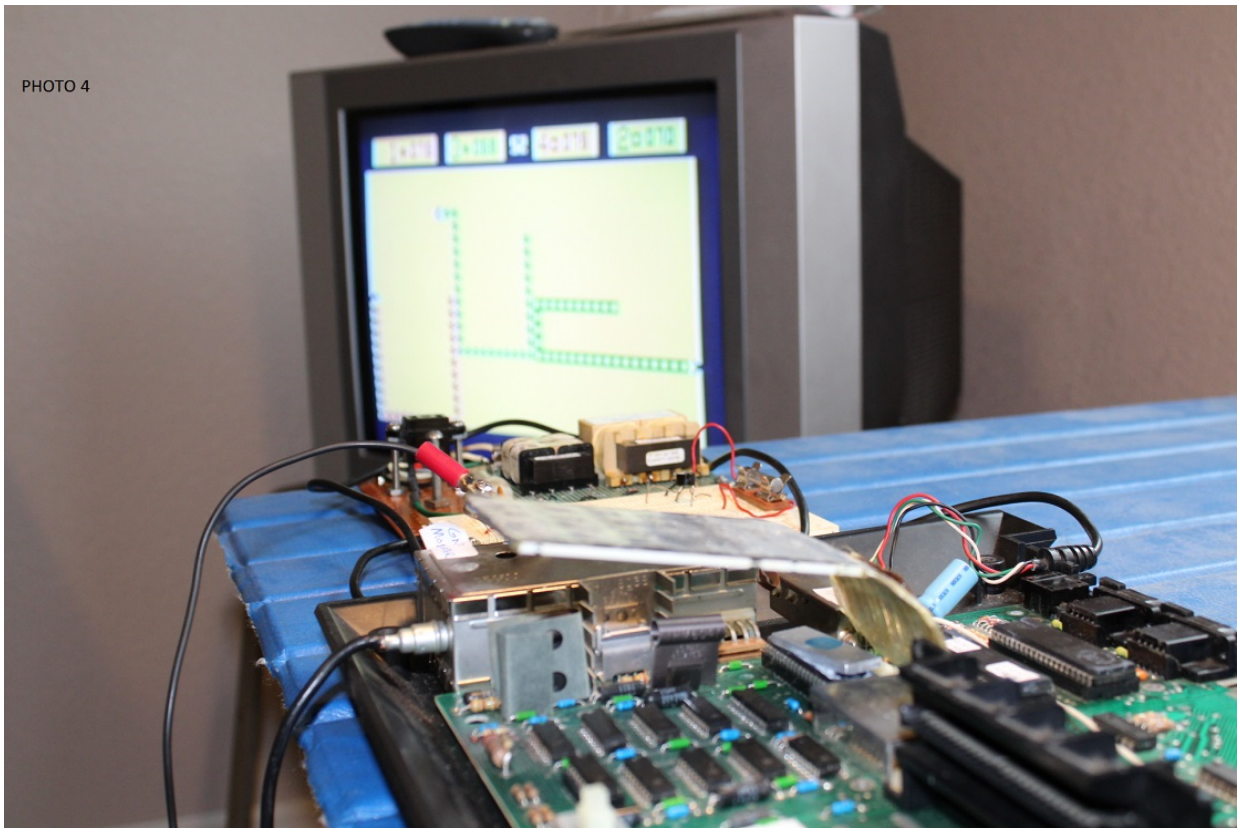


PHOTO 2
115/230V~ CLASS
50/60HZ B/T
PREM
MEXICO
0.5A@12V
TAMURA
TEMECULA, CA
3FU12-475
INPUT
OUTPUT
115-230V
12.6V
6.3V
50-60HZ
0.475A OR
0.95A
0.95A@6.3V
MALAYSIA
U.S. PAT DES NO. 235554

(Photo 2)

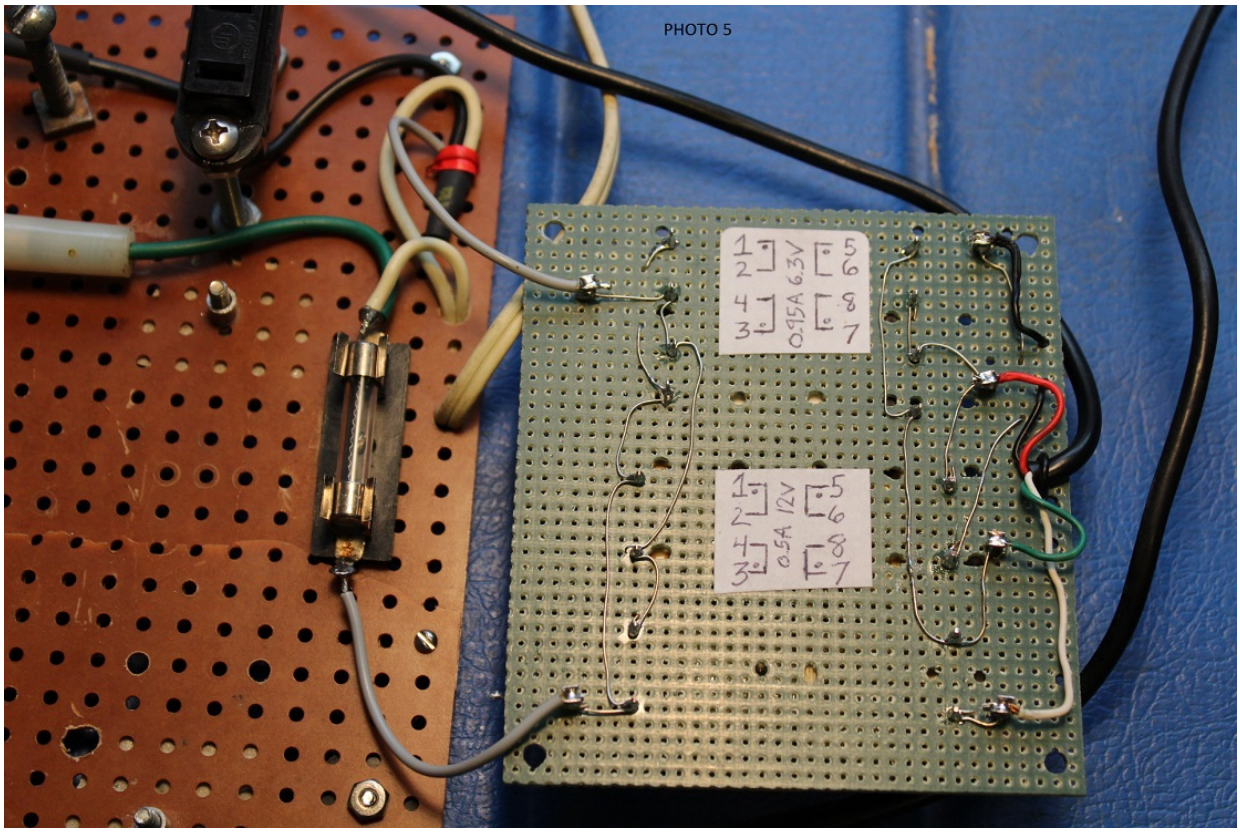


(Photo 3)



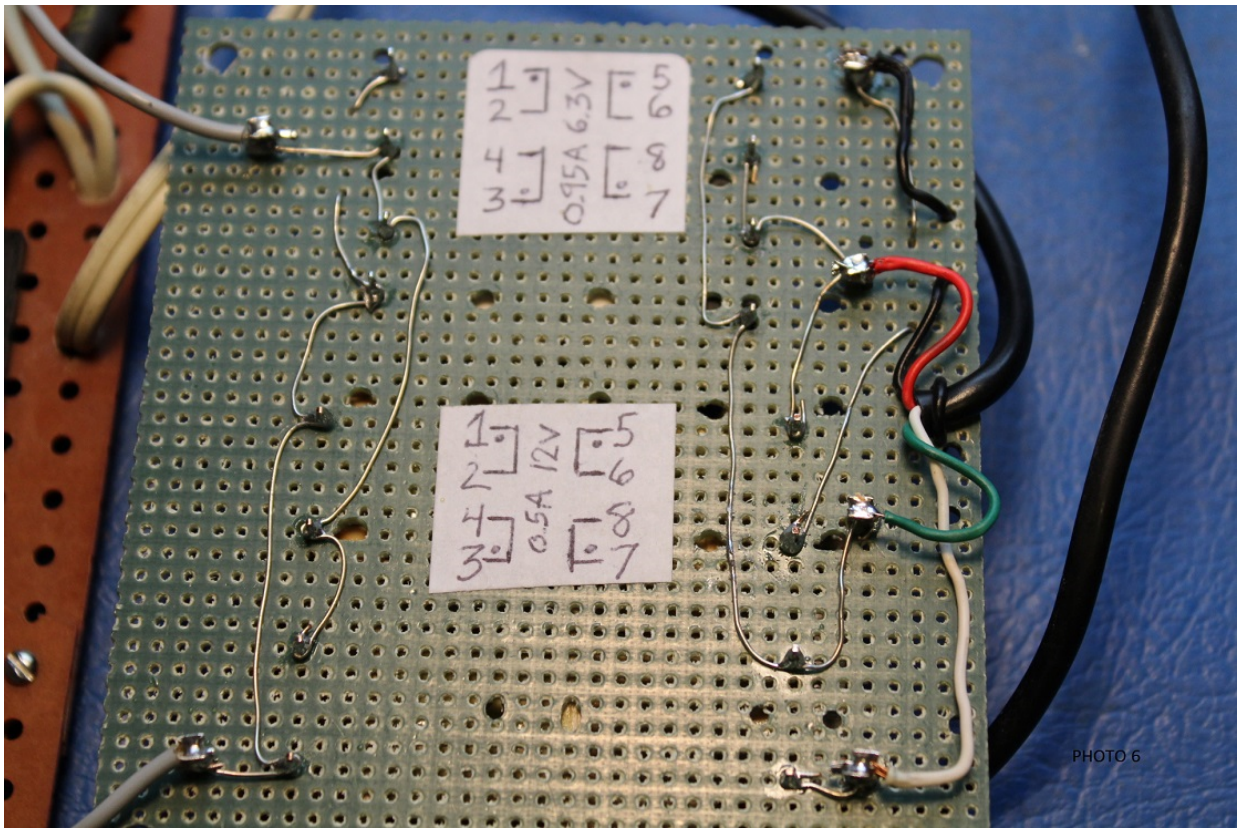
(Photo 4)

The Jameco substitution to the left of the motherboard running Checkmate as a test demo as seen vaguely on my 19" Toshiba TV.



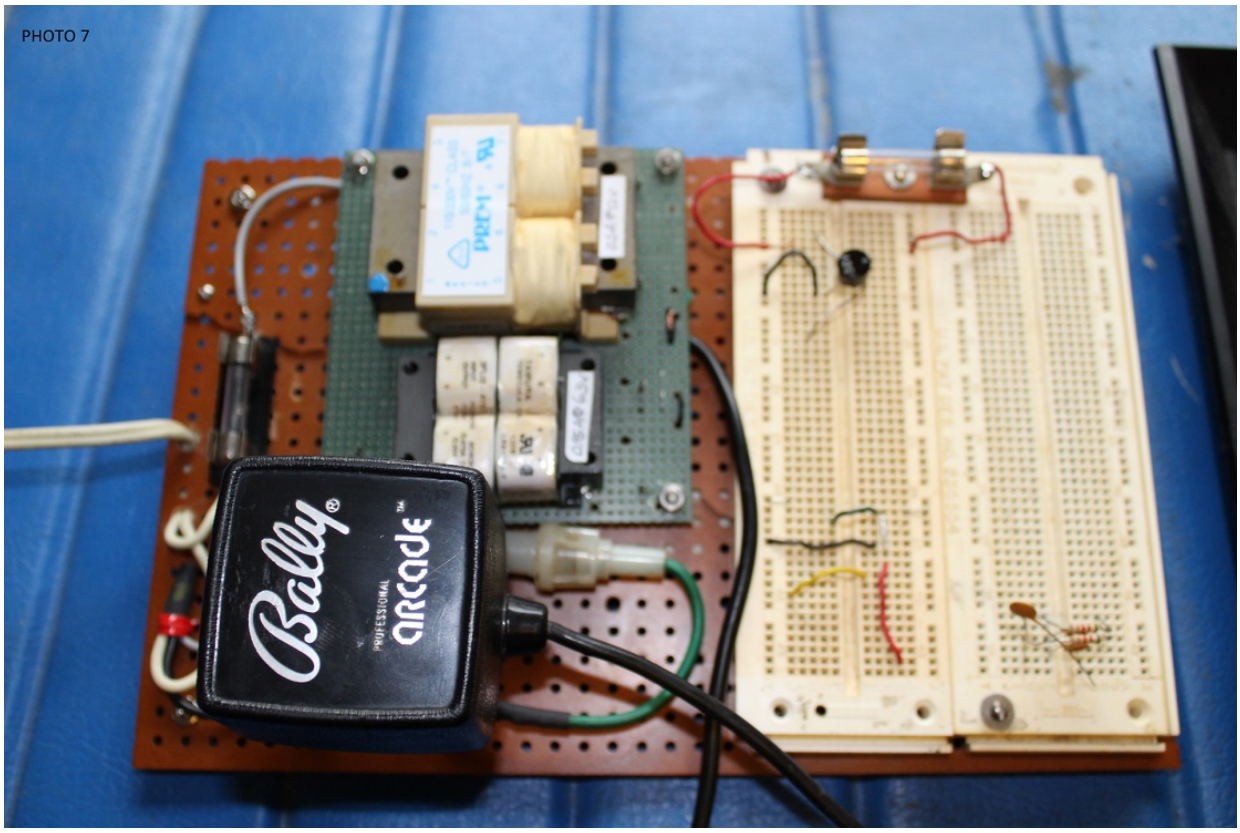
(Photo 5)

The xfmr hobby board flipped over to view its bottom and wiring to the primary fuse and standard black Bally 4 conductor power cable.

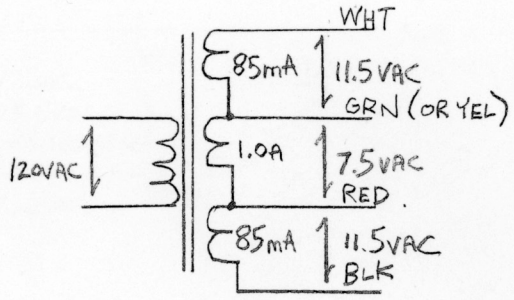


(Photo 6)

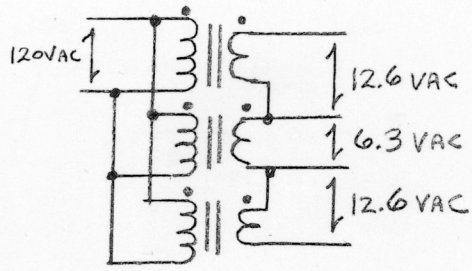
A closer view of the bottom of the xfmr board.



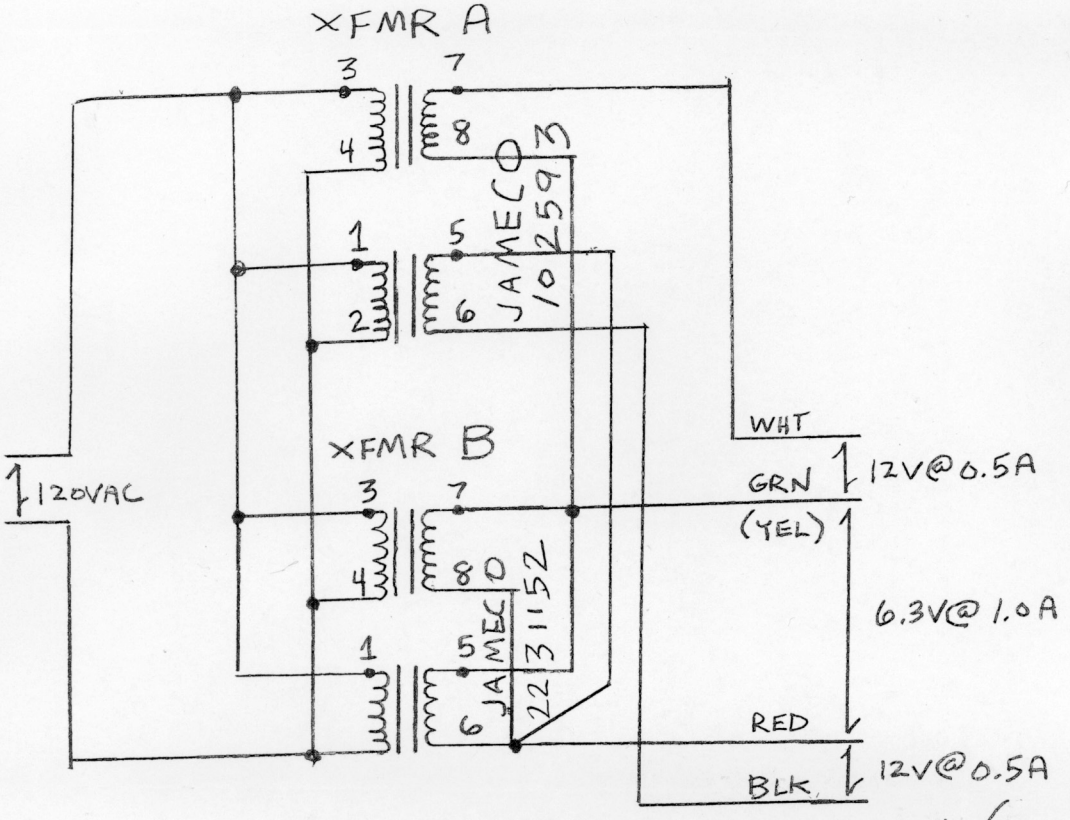
(Photo 7)



BALLY POWER TRANSFORMER
FIGURE A



POWER XFMR SUBSTITUTION
USING 3 XFMRS
FIGURE B



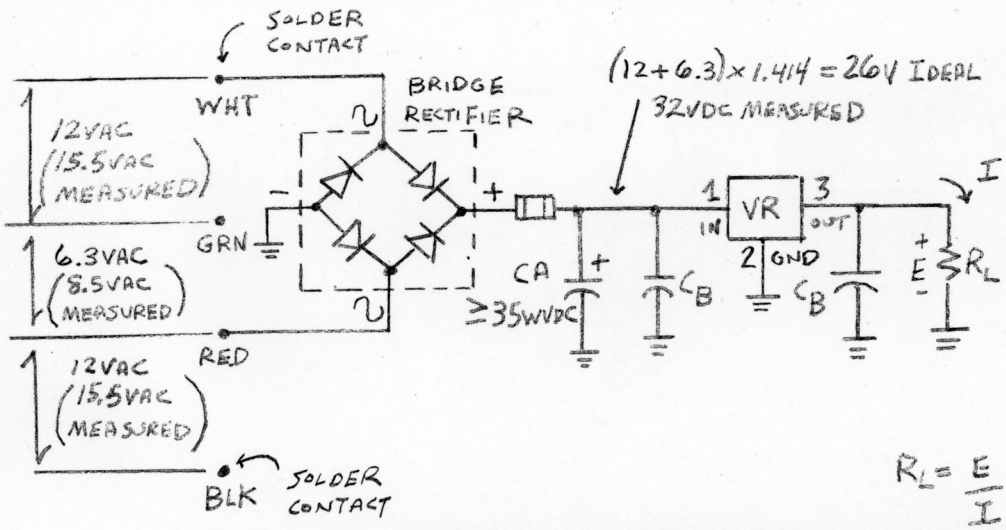
SECONDARIES

XFMR A TOP END WINDING

XFMR B (WIRED IN PARALLEL) CENTER WINDING

XFMR A BOTTOM END WINDING

JAMECO PWR XFMR SUBSTITUTION (TOP VIEW)
USING 2 SPLIT-BOBBIN XFMRS
FIGURE C



VR = VR1 OR VR2

LM342P-12
LM342P-15

LM342P-10

C_A = 1500µf OR USER'S CHOICE RATING ≥35WVDC

C_B = 0.1µf OR USER'S CHOICE (OPTIONAL)

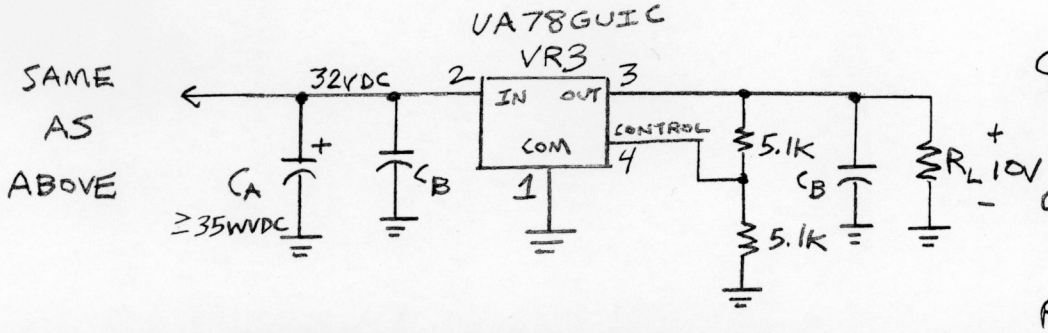
R_L = LOAD RESISTOR USER'S CHOICE

$R_L = \frac{E}{I}$ $P_L = I^2R = \frac{E^2}{R_L}$ RATE RESISTOR POWER WATTAGE HIGHER THAN P_L

↑ POWER

EXAMPLE USE 250Ω 5W RESISTOR

TEST CIRCUIT 1
VOLTAGE REGULATORS VR1, VR2



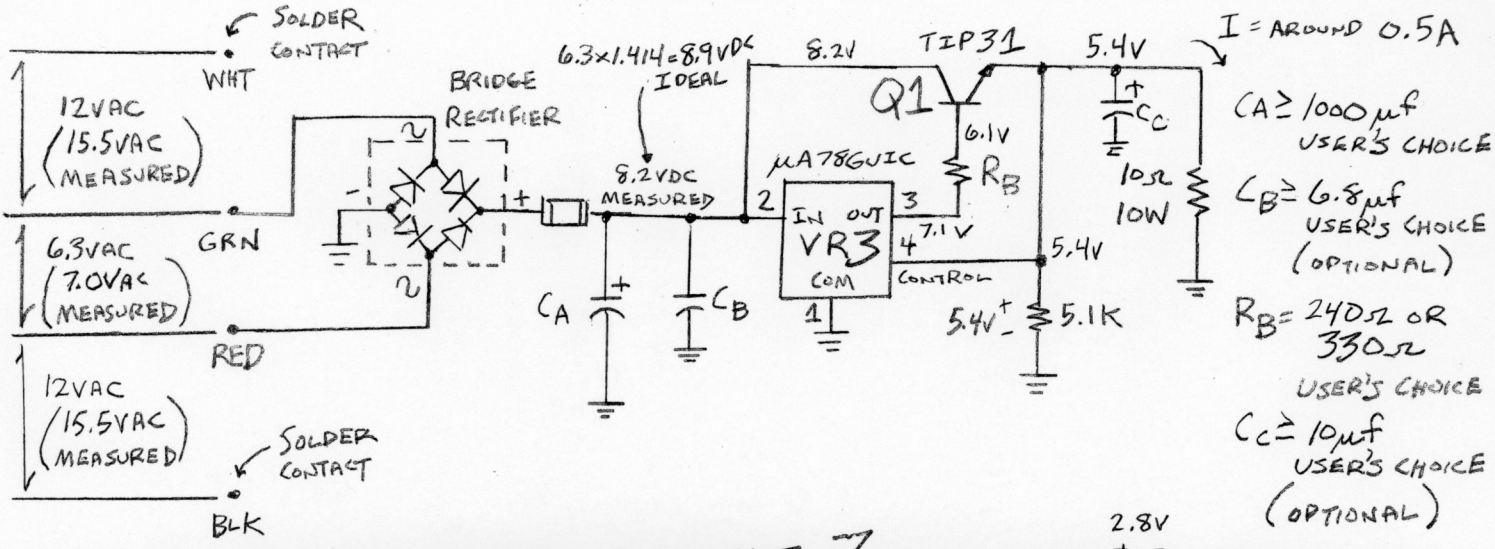
C_A = 1500µf OR USER'S CHOICE RATING ≥35WVDC

C_B = 0.1µf OR USER'S CHOICE (OPTIONAL)

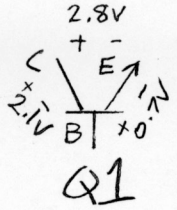
R_L = LOAD RESISTOR USER'S CHOICE

EXAMPLE USE 250Ω 5W RESISTOR

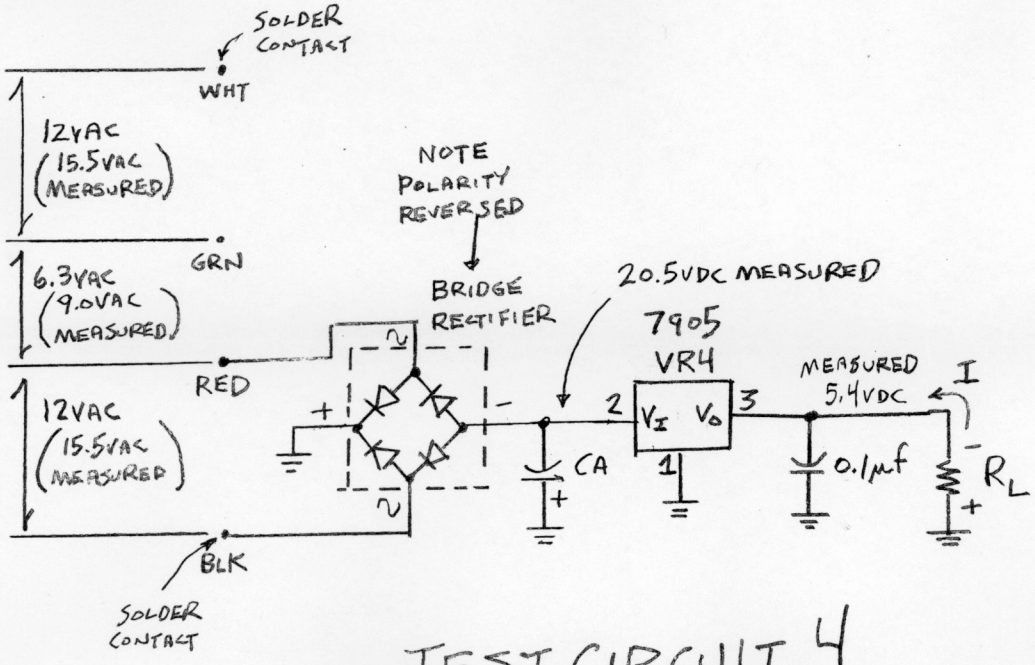
TEST CIRCUIT 2
VOLTAGE REGULATOR VR3 (ALONE)



TEST CIRCUIT 3
POWER PASS TRANSISTOR Q1 (ALONG WITH VR3)



MEASURED VOLTS
B-E 0.7V
B-C 2.1V
C-E 2.8V



CA ≥ 100μf USER'S CHOICE
RL = USER'S CHOICE

TEST CIRCUIT 4
VR4, -5V SUPPLY