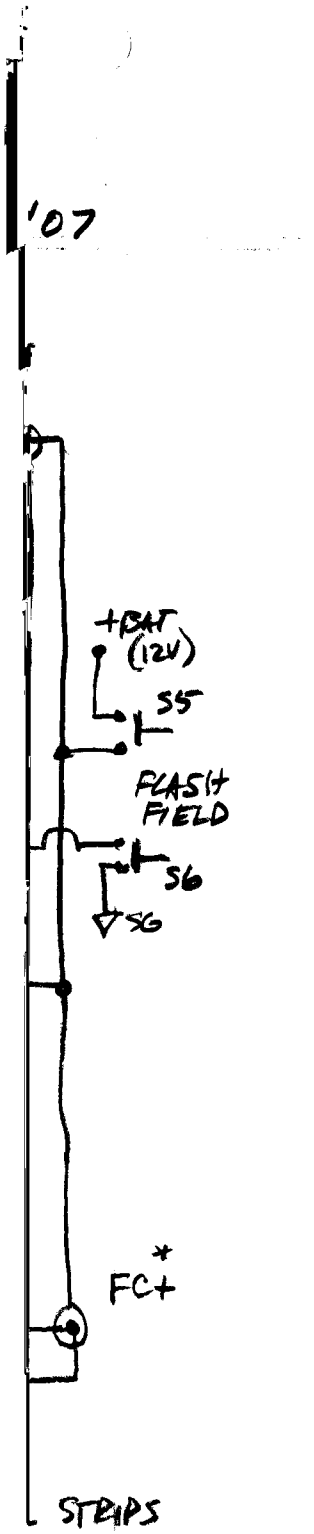

'07
+BAT (12V)
55
FLASH FIELD
56
SG
FC+
STRIPS

Electronic Regulator for ST-3
System Diagram Notes

Components:

TF1 Toroidal transformer provides excitation power. 240 V primary, 115 V secondary, 500VA (Surplus had it on hand.) Slightly lower voltage and VA would be OK. Possible to eliminate with design change, the design originally had 48VAC exictation, which proved inadequate. Harmonic winding can provide over 300V peak on surge.

TF2 Transformer to provide regulated 12VDC to regulator board. I used Talema 70012K 12V seconary (x2 in parallel) for total of 3.2 VA. DC converstion via bridge rectifier, 4700 uF capacitor, LM7812 linear regulator.

TF3 Transformer to provide full wave rectified 7VAC. I used Amvec 70000K 1.6 VA (tiny toroidal).

D1, D3 Power Bridge Diodes, metal case. Mounted External heatsinks. I used 800V+, 25amp units I had on hand.

D2 Power Diode. I used one of unknown rating. 800V, 6 amp would be safe.

RL1 Latching Relay, 12VDC coil. I used DS2E-ML2-DC12V. This coil only switches the main power relay coil 120VAC current, so is a tiny PC board mount type.

RL2 Main Power Relay. I actually used two SPST N.O. relays, 20A, 120VAC coil. (Omron- had them on hand.) A DPST relay would also do the job.

RL3 DPDT relay is used to switch between Harmonic winding source for startup, to the TF1 transformer source once the regulator board is powered up and the power on delay is over (3 seconds). I used a Potter and Brumfield RTE240112F. 8A, 12vdc coil. I woud probably use something a little bigger, but this was designed for the original 48VAC excitation.

S1 Toggle switch disables the harmonic. Ths is located by the HOL (House of Lister) door, and allows me to have the generator spinning with no exitation for lower EMFs. It is not needed for regular folks.

-

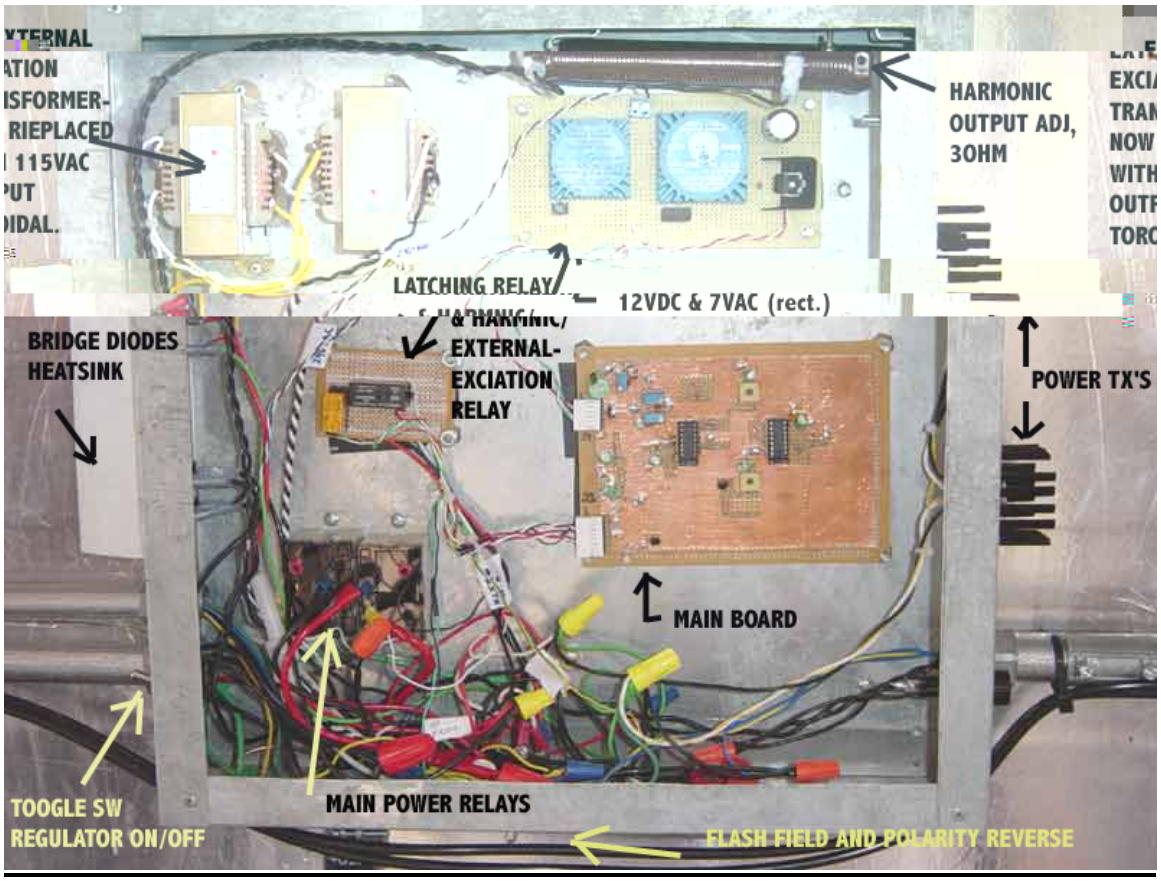
S2	**DPDT switch allows the polarity of the field coil brushes to be switched…NOT TO BE USED WITH GENERATOR RUNNING! The "flash field" buttons should be used after this switch is changed, every thousand hours or so.**
S3	**Generator Off push button near door. Allows me to switch off the main power relay when entering the HOL. The same signal is used (Gen_off) by the regulator board if an over or under voltage timeout is detected. My Lister-Picaxe control processor also drives this signal to shut down generator output.**
S4	**Generator ON push button near door. Allows me to switch on the main power relay manually when leaving the HOL. The same signal is driven by the Lister-Picaxe control processor to turn on the generator output.**
S5,S6	**Flash Field Buttons. These are only to be used (simultaneously push both buttons) when the ST-3 generator is not spinning, after changing the polarity of the field coil brushes to prolong their life. They flash the field coil with 12VDC from the battery.**
S7	**Switch to disable the electronic regulator. If this is open (off), then the electronic regulator never powers up, so the generator will continue to operate only on the harmonic winding, The regulator board and it's power board aren't needed to operate in the harmonic only mode.**
TX1, TX2	**T0-3 NPN Darlington Power transistors (BU941) used to "soft switch" the excitation transformer TF1 current through the field coil.**
R1	**100 watt adjustable 3 ohm power resistor. Dropping resistor required to get harminic winding produced AC on my ST3 to a reasonable voltage range. Some ST3 Heads don't need this,**
L1, L2	**240VAC between this two AC outputs from the ST Head. As shown in the system diagram- they are AFTER the main power relay, which powers the regulator power board. L1 and L2 then also go to the main power breaker in the HOL, to my pump house, and down to the step down transformer near the shop to make some 120VAC. Shop power is provided through circuit breakers at the step-down transformer/breaker panel, behind the shop.**

N	**The neutral wire output of the ST Head. Only used for some small relays here, and in the pump house.**

Bruce's ST-3 Regulator Documentation

This design was originally for 48V excitation, which I found to be inadequate for motor starting loads. With a portable digitial scope I captured harmonic output from the stock Harmonic excitation system of 400 volts peak (for maybe 4 msecs) when a motor load was switched on. I then upped my power transformer to one I had on hand which was 115VAC output. This provides ample motor starting loads, but be warned, you better have your belt tight, as the generator will now try much harder to maintain voltage.

Here's a picture of the completed assembly with the cover off :



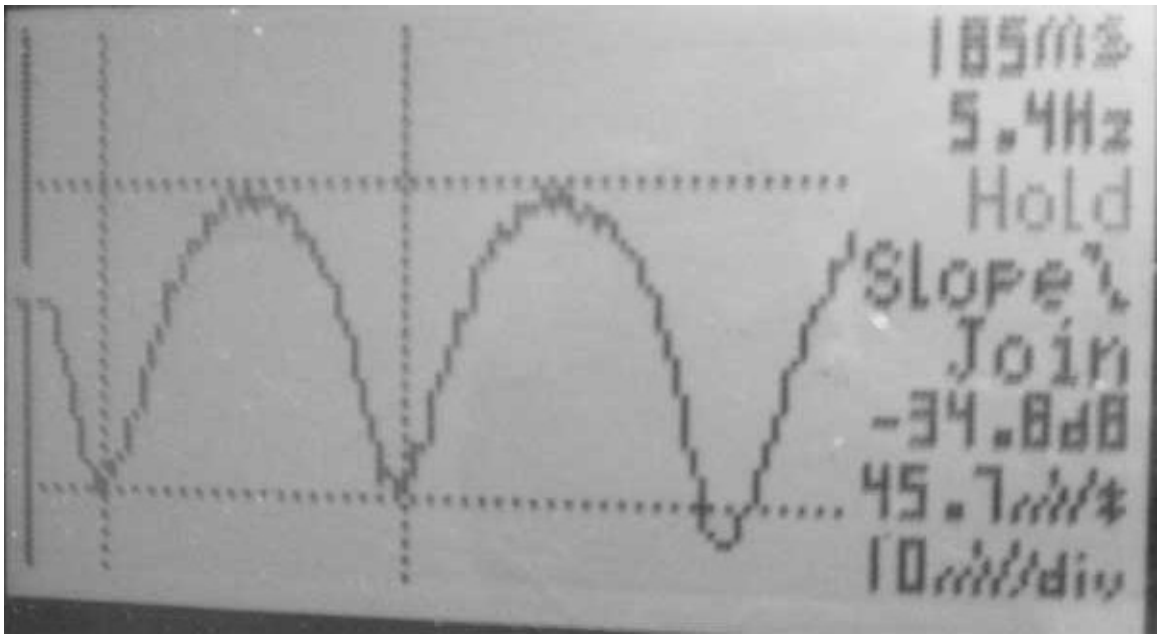
This was before I replaced the two 24VAC transformers in the upper left corner with one 115V toroidal transformer (500VA). The BU941 transistors were used to allow very slow switching for reduced EMI. They have a 100-200usec turn on/off time in the current design, which does reduce high frequency noise significantly.

Given the higher voltages necessary for starting surge, I'm now proposing a different approach for most applications- using the line voltage directly as exciation, without a transformer. I have a proposed circuit for that, but it's not part of this project documentation.

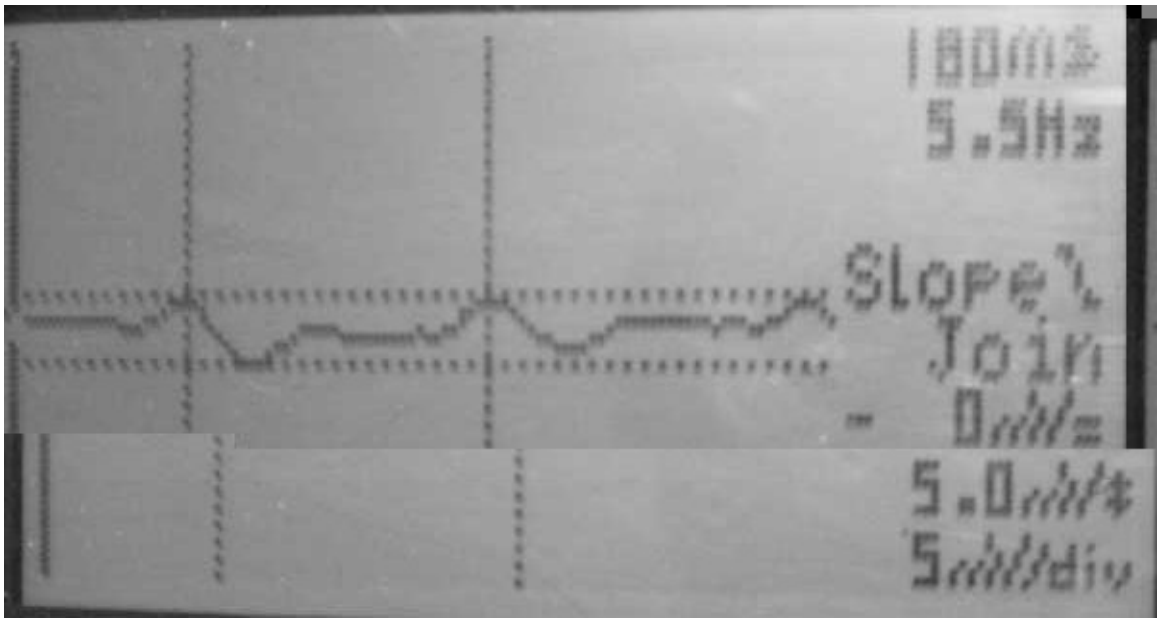
This circuit has shown to be very effective in reducing “Lister Flicker”- the variation in ouput voltage caused by the 5.5Hz power stroke of the 650 RPM Listeroid 6/1.

Here are some scope shots taken using a 3 stage RC filter to allow a closer look at this low frequency phenomina:

First is the AC output using the stock harmonic winding on my ST3:



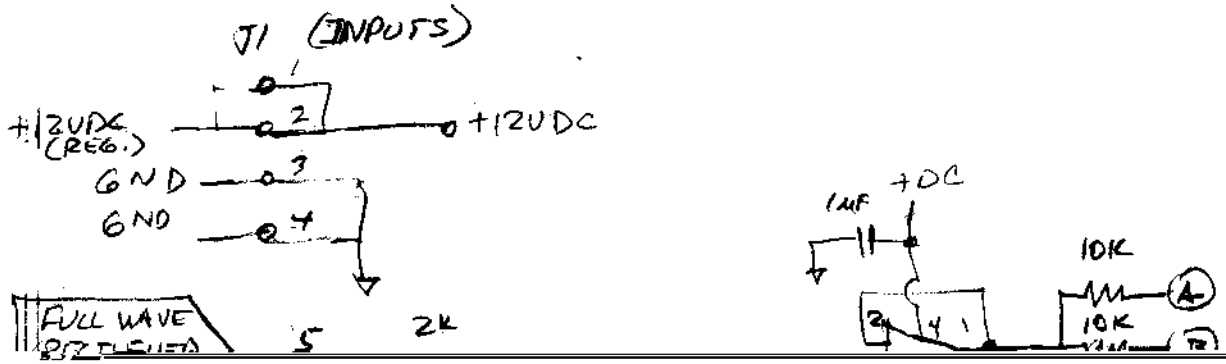
You can see the output voltage is lowest just before igntion. This variation is just a volt or two, normally, unless you have some sort of weird oscillation going on.



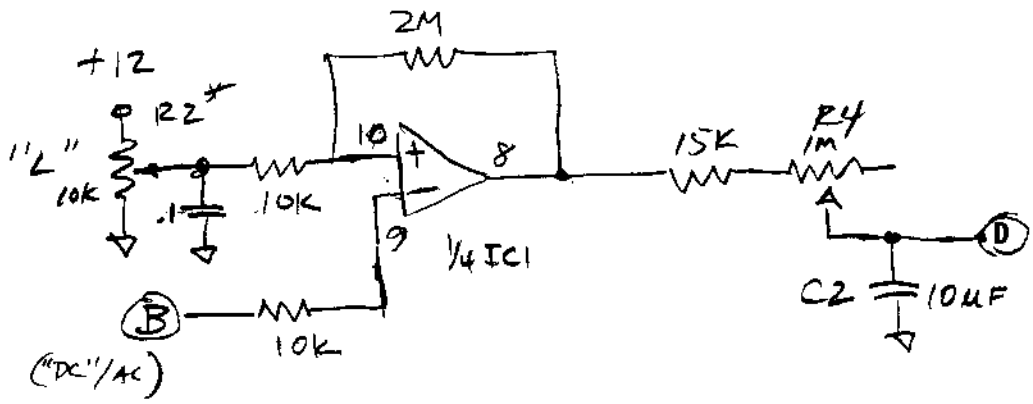
This is the ‘scope shot with the electronic regulator switched on. Note that the remaining low frequency AC voltage variation is so small that I had to switch to a different scale. From over 46 mv variation, peak to peak, to less than 5 mv. This is an 90% reduction.

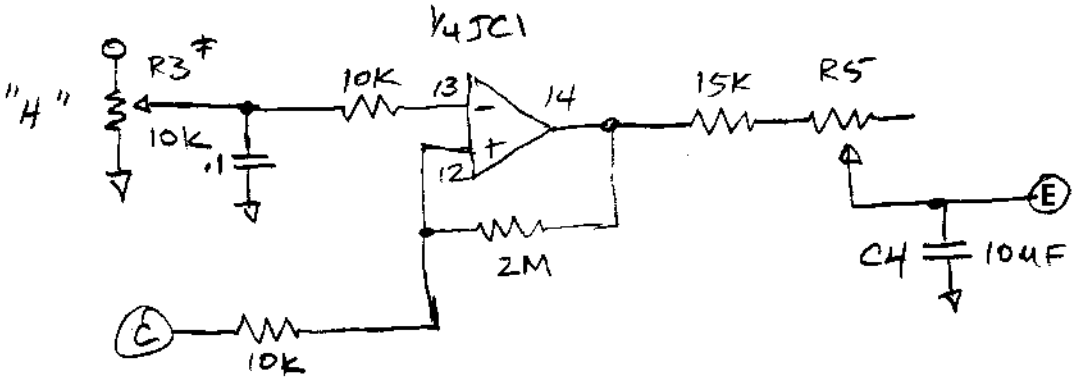
Note that for a given ST type head, you may need to adjust the AC to DC filter on the main board to avoid some type of LCR oscillation, should it appear (as flicker or a twitchy AC voltage indicator). Change the C values to something less, for example. I only saw such oscillation when experimenting with a 2 stage RC filter instead of the 1 stage as shown in the plans. The two stage filter created MASSIVE flicker- and woud only be suitable as a feature to drive off annoying guests.

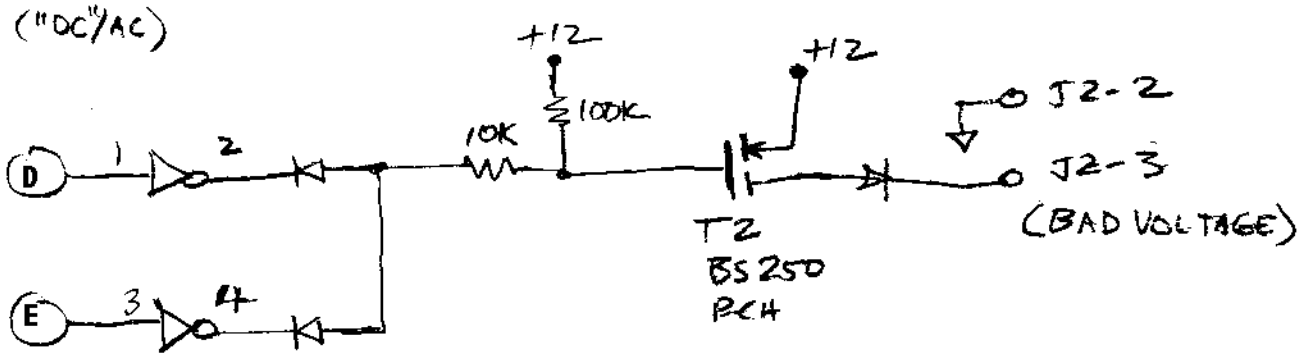
SF-3 GENERATOR REGULATOR SCHEMATIC PAGE 1



ST-3 REGULATOR SCHEMATIC PAGE 2





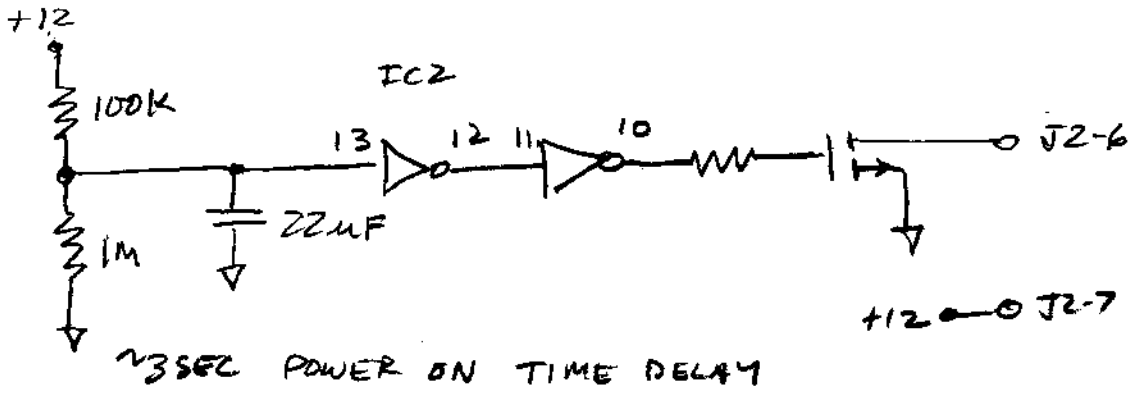


PIN 7 - IC2 GND

*R2 - LOW VOLTAGE SET POTENTIOMETER (MULTI-TURN)

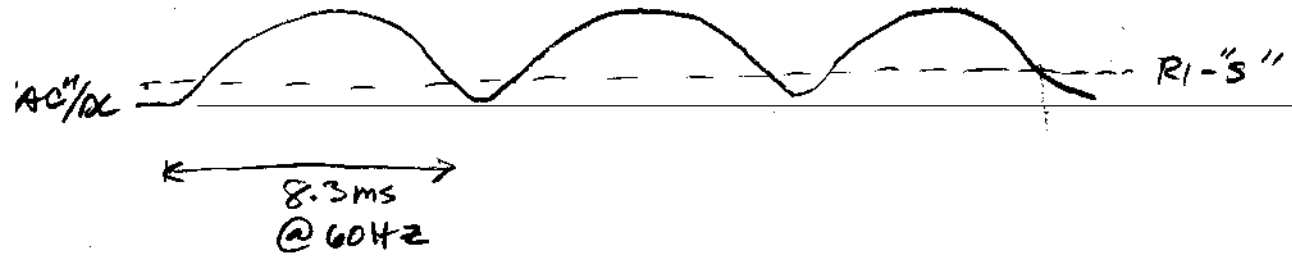
≠R3 HIGH " " " "

ST-3 REGULATOR SCHEMATIC PAGE 3



ST-3 REGULATOR
OPERATION

REGULATED +12VDC AND FULL WAVE RECTIFIED (FWR) 60VAC ARE PROVIDED TO REG. BOARD. THE FWR VOLTAGE IS FILTERED AND THEN BUFFERED BY IC1 OP-AMP1 (VOLTAGE FOLLOWER). THIS "AC"/DC LEVEL IS THEN COMPARED TO THE "SET" VOLTAGE POTENTIOMETER (R1-"S"). THE POWER DARLINGTON BASE IS TURNED ON IF THE VOLTAGE IS TOO LOW.



AS THE AC VOLTAGE DROPS, THE 120HZ PULSES TO THE POWER DARLINGTON INCREASE IN WIDTH, AND MAY BECOME CONTINUOUS (FULL ON) FOR A SURGE

THE ROTOR FROM BURNOUT, IN CASE OF CIRCUIT FAILURE.

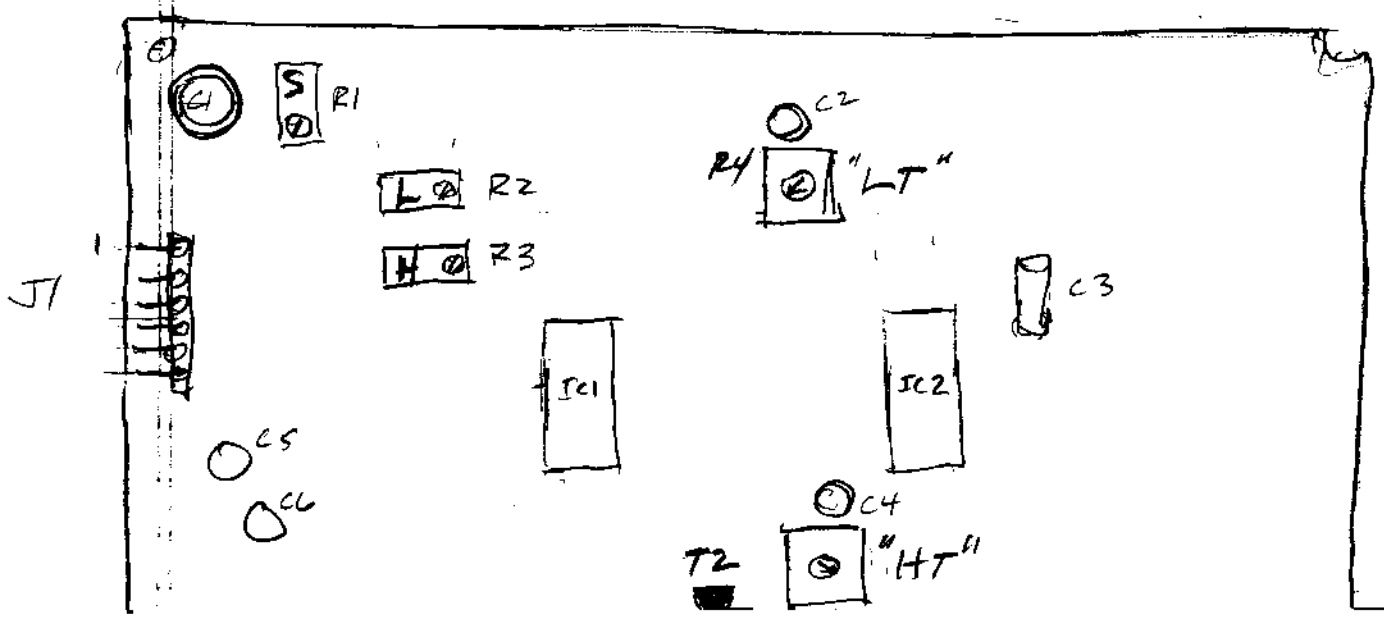
ST-3 REGULATOR
OPERATION

THE 2ND & 3RD OP AMPS OF IC1 (TS924IN) COMPARE THE "AC"/DC LEVEL FOR LOW AND HIGH VOLTAGE THRESHOLDS SET BY POTENTIOMETERS R2 ("L") AND R3 ("H").

THESE IN TURN START CHARGING CAPACITORS C2 AND C4 THROUGH POTENTIOMETERS R4 (LT) AND R5 (HT). R4 IS THE LOW VOLTAGE TIME DELAY ADJUSTMENT AND R5 IS THE HIGH VOLTAGE TIME DELAY ADJUSTMENT.

WHEN EITHER LOW OR HIGH VOLTAGE CONDITIONS PERSIST FOR LONG ENOUGH (0-9 SECONDS AS SET VIA R4, R5), THE SCHMIDT TRIGGER CMOS INVERTERTERS (HERE USED AS AN ANALOG COMPARATOR) OF IC2 WILL GO LOW, WHICH WILL TURN ON T2 (BS-250, P-CH MOSFET). THIS SIGNAL GOES TO CONNECTOR J2-3, WHERE IT CONNECTS TO A LATCHING 12V COIL RELAY WHICH DISCONNECTS A POWER RELAY, WHICH DISCONNECTS ALL AC LOADS. THE REGULATOR IS POWERED BY THE EXTERNAL LOAD RELAY, SO IT IS ALSO SHUT DOWN BY THIS ACTION.

BOARD LAYOUT:

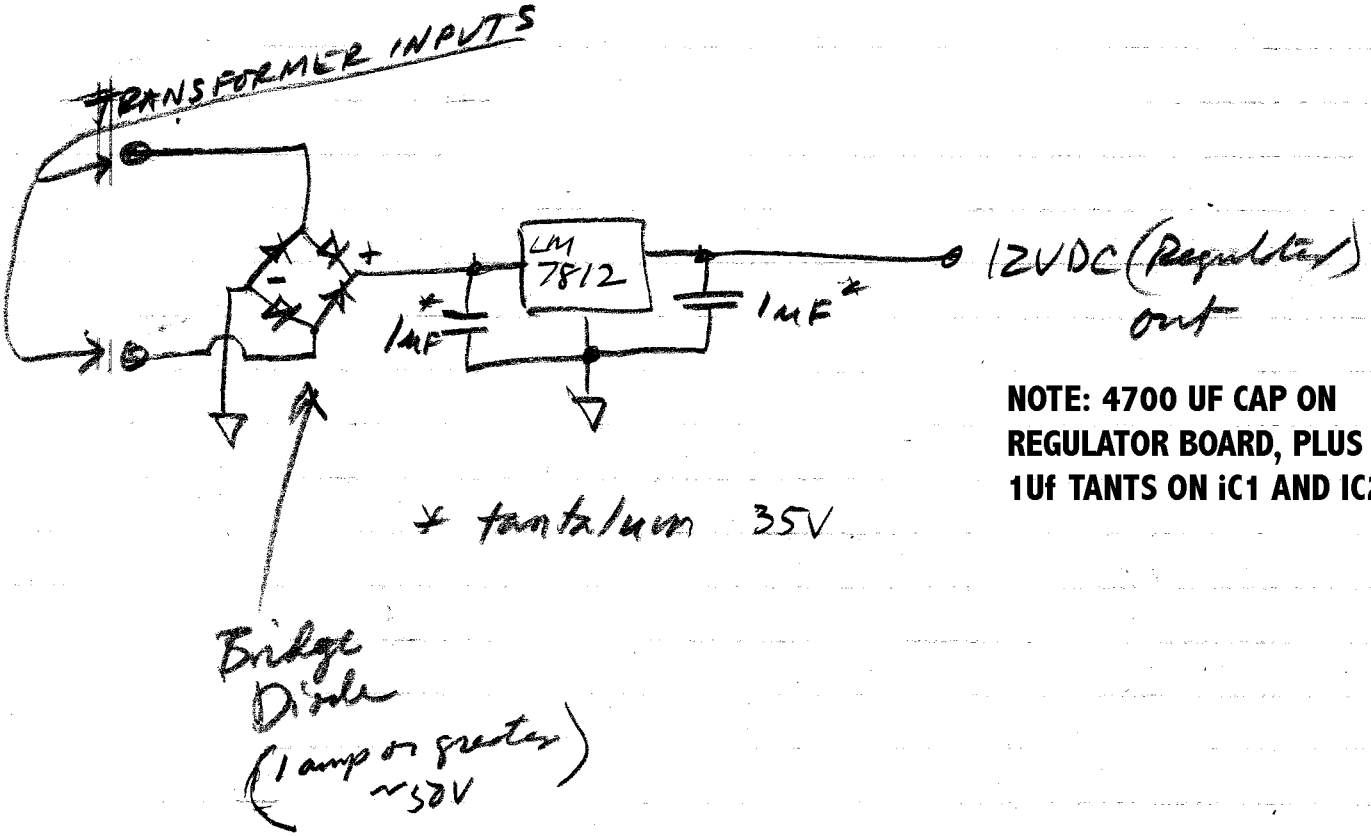


ST-3 REGULATOR
CONNECTORS

J1-1	+12VDC REG
J1-2	" "
J1-3	GND
J1-4	GND
J1-5	6VAC, FULL WAVE RECTIFIED
J1-6	GND

J2-1	PULSE OUT (POS) TO POWER DARLINGTON (NPN)
" 2	GND
" 3	BAD VOLTAGE (POS+12) TO LATCHED RELAY
" 4	+12
" 5	GND
" 6	TIME DELAYED POWER ON (GROUND)
" 7	+12V
J2-8	NC

12VDC REGULATED SUPPLY



NOTE: 4700 UF CAP ON REGULATOR BOARD, PLUS 1Uf TANTS ON iC1 AND IC2