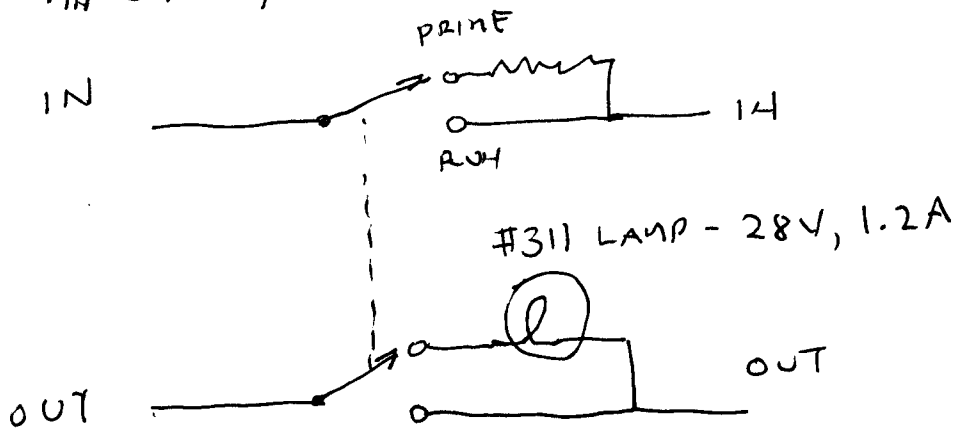


### LIMIT INRUSH CURRENT -

INPUT SIDE DOES NOT MATTER, ONLY CHARGING  $\sim 2000 \mu\text{F}$ , AND LIMITED BY SOLAR PANEL. COULD PUT A RESISTOR IN SERIES, BUT THAT WOULD PREVENT PANEL FROM CHARGING OUTPUT, IF THERE WAS NO BATTERY CONNECTED.

COULD DESIGN SOFTWARE TO DETECT HIGH IMPEDANCE POWER INPUT, AND STOP CONVERSION... OR POLL EVERY 5 SECONDS, AND ONLY START IN CASE OF LOW IMPEDANCE,  $\rightarrow$  IF  $V_{IN} \leq 12\text{V}$ , WAIT 5 SEC.



IF I USED A BIDIRECTIONAL CURRENT SENSOR ON THE OUTPUT, COULD DETECT BACKFLOW CURRENT, BUT EVEN WITHOUT THAT, COULD MONITOR OUTPUT VOLTAGE  $E$  FOR STABILITY.

BOARDS ARRIVED FROM PCBWAY.COM. TOOK 17 DAYS FROM UPLOAD OF GERBERS. SLIGHT SILKSCREEN MISALIGNMENT - MIGHT BE OFF 5-10 MIL ON BOTTOM - STILL USABLE.

WAITING ON SUPERCAPS + 20 PIN IC SOCKET FROM Mouser. WHAT COULD I ASSEMBLE NOW?

→ INPUT + OUTPUT PHOENIX CONNECTORS

→ INPUT VCC AND VDRIVE SUPPLIES - MUST HAVE ACS723'S IN PLACE

→ OUTPUT FLASHER

→ TEST POINTS

22 NOV 15. Mouser ORDER CAME YESTERDAY. DID NOT OPEN YET.

MADE VIDEO OF HOW I SOLDER SURFACE MOUNT PARTS WITH TWO IRONS. MISSING A FEW RESISTORS, SO GOT THOSE AT HALTED.

HALTED ONLY HAS 5% RESISTORS IN 1206.

FOUND I WAS MISSING 1  $\mu$ F 50V CAPACITORS. ONLY 25V CAPS

AVAILABLE AT HALTED. MAYBE WILL USE 10  $\mu$ F/50V FROM

Mouser INSTEAD. ONLY PLACE IT MATTERS IS SAFETY FLASHER

ASTABLE MULTIVIBRATOR, AND CAN ADJUST RESISTORS TO

COMPENSATE.

CERAMIC CAPS MEASURE LOW, ~~OR~~ AT LEAST, HIGH CAPACITY ONES DO. YES,

TYPE

LABEL

MEASURED.

PTC BRINGUP. INSTALLED MOST COMPONENTS, EXCEPT IN POWER PATH SUCH AS MAIN INDUCTOR, MAIN SWITCH, SUPERCAPS, SOCKET FOR PICAXE. HOOKED UP 24V TO SOLAR INPUT.

• VCC FROM LM317 = 5.2V

• VDRIVE FROM OTHER LM317 = 9.6V

VCC LM317 IS HOT - NOT BURNING HOT, BUT HOT. SHOULD NOT BE PASSING SO MUCH CURRENT, MAYBE FLOATING INPUTS OF LM393 ARE MAKING IT DRAW POWER?

DVM SHOWING 42.8mA DRAW FOR WHOLE CIRCUIT.

PICAXE PREVIOUSLY MEASURED AT 2mA, EVEN WHEN RUNNING, ~~AC572~~ AC5723 SUPPLY CURRENT IS 9mA TIP, 14mA MAX IF ALL 3 ARE CLOSE TO MAX, THAT EXPLAINS IT. MIGHT DECIDE TO HEAT SINK THE PART, COULD CLIP TO CHASSIS WITH MAIN SWITCH.

— LINAXEPAD CAN COMMUNICATE W/ PICAXE - DID FIRMWARE VERSION CHECK.

— FOUND ONE AUXILIARY LED - LED2 - NOT WORKING - PUT IN BACKWARDS. FIXED.

— WROTE SIMPLE PROGRAM TO WAIT FOR PUSHBUTTON THEN FLASH LEDS IN ALTERNATION, WORKS. ptctest1.bas

Ø DECIS. FORGOT TO ORDER LM340Z. THOUGHT I DID, BUT CAN'T FIND IT IN ANY SHIPPING MANIFESTS.

WROTE PROGRAM TO TEST SENSORS

IN VOLTAGE = 24.5 V RAW READING 245, SAH TO 242 WHEN LAMP PUT ACROSS SOLAR POS → GND

IN CURRENT = 107 NOMINAL, JUMP TO 155 W/ LAMP CONNECTED.

MID CURRENT = 103 NOTHING CONNECTED

OUT VOLT = 0

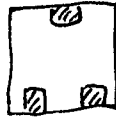
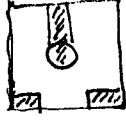
OUT CUR = 0103 NOTHING CONNECTED

IN VOLT = 10.2V RAW = 102, OTHER READINGS SAME

IN VOLT = 7.55V RAW = 74, IN = 12.88V RAW = 129

CONCERNED ABOUT 4mm TRIMMER FOOTPRINT,

COMPLETELY UNDERNEATH COMPONENT, HARD TO SOLDER WITH IRONS.



1 TURN TRIMMER

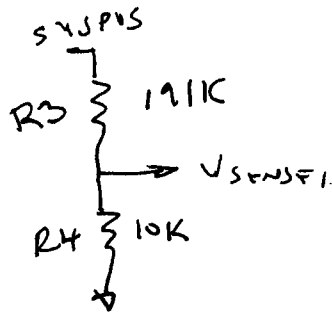
5 TURN TRIMMER

WILL MODIFY FOOTPRINT IF THERE'S EVER A REV 2.

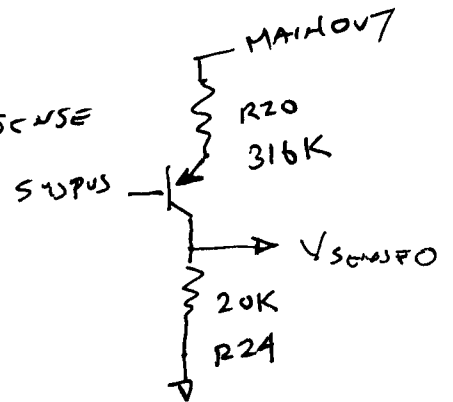
1-TURN TRIMMER LOOKS LIKE IT WILL SHORT, BUT IN ACTUAL SOLDERED PART R25, IT WAS NOT A PROBLEM.

03DEC15. ACS 723 - 40 AU 100 mV/A  
 - 20 AU 200 mV/A

IN VOLT SENSE



OUT VOLT SENSE



$$V_{SENSE1} = \frac{10}{10+191} (V_{SYSPOS}) = 0.050 V_{SYSPOS}$$

$$= 0.102 V / COUNT$$

$$V_{SENSE0} = 20K \cdot \frac{(V_{MAINOUT} - 0.6)}{316K} = 0.063 (V_{MAINOUT} - 0.6)$$

ASSUME TRANSISTOR  $\beta = HIGH$

$$= 0.063 V_{MAINOUT} - 0.378V - 0.04V$$

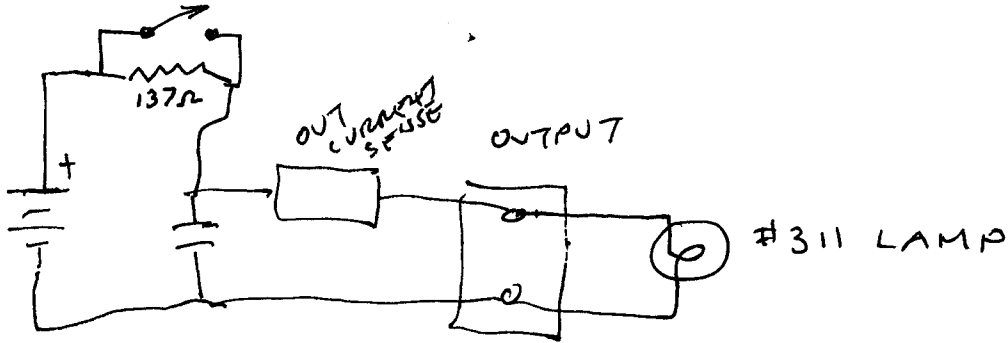
$$= 0.081 V / COUNT$$

$V_{CC} = 5.2V$  SHOULD ADJUST RESISTORS FOR SLOPE, BUT FOR NOW, IGNORE

$$1023 COUNTS = 5.2V = 5.1 mV / COUNT$$

MORE SENSOR MEASUREMENTS.

24.5V INPUT, USING 12V BATTERY OH OUTPUT AS FOLLOWS:



	IN VOLT	IH CURRENT	MID CUR	OUT VOLT	OUT CUR	TEMP
OUTPUT NOT CONNECTED	24.5	107	102	1	104	225-230 (FLUATING)
OUTPUT CIRCUIT CONNECTED (SW OFF)	"	"	"	1	106	"
SW TURNED ON	"	"	"	154	121	"
SW TURNED OFF			1-5 SEC CAPACITOR CURRENT	6	106	
				2	105	
				1	106	
OUTPUT DISCONNECTED				1	104	

ACCIDENTALLY SHORTED LIGHT BULB LEAD TO PICAXE, BURNED IT OUT, BOTH LEADS WENT ON. MAYBE BURNED DARLINGTON, TOO? YES Q6.

REPLACED PICAXE. REPLACED Q6. BACK ON TRACK.

	IN VOLT	IH CUR	MID CUR	OUT VOLT	OUT CUR	TEMP
NORMAL	24.5	108	103	1	104	224 ~ 230
#311 LAMP STOPS → Q1 SOURCE	24.3	156	128	1	104	224

SHOULD ~~ADJUST~~ ADJUST DIVIDERS FOR 0.1 VOLT / COUNT FOR EASY COMPUTATION. ALSO TRIM VDD TO 5.0 VOLTS. BUT CAN USE INTERNAL 2.048V REFERENCE ANYWAY.

FOR NOW, VALIDATE BOARD BOARD READINGS.

IN VOLTAGE = 245 COUNTS = 24.99 V.

IN CURRENT = 107 NOMINAL, WHILE 0 CURRENT SENSORS READ 103.

4 COUNTS = ~~20.4 mV~~ 20.4 mV = 0.0204 x

20.4 mV x  $\frac{1 \text{ A}}{200 \text{ mV}}$   $\approx 100 \text{ mA}$

~~200 mV~~  
-20 PART USED

THAT'S HIGH, IT PRESUMES, THOUGH, THAT THE ZERO CURRENT READING IS 103. IF IT'S 105, EVERYTHING IS GOOD.

OUT CURRENT THRU 137Ω RESISTOR.

DID NOT RECORD BATTERY VOLTAGE, BUT THINK IT MIGHT HAVE BEEN ~12.8V.

$\frac{12.8 \text{ V}}{137 \Omega} = 93 \text{ mA}$

~~2 COUNTS~~ = 1 COUNT = 5.1 mV x  $\frac{1 \text{ A}}{100 \text{ mV}} = 51 \text{ mA / COUNT}$

40 A PART. 2 COUNTS = 102 MA GOOD.

WITH OUTPUT SWITCH FLIPPED, OUT CUR = 121 COUNTS.

121 - 104 = 17 COUNTS NET.

17 COUNTS · 51 mA / COUNT = 0.87 A  
FAIR FOR #311 @ 12 V

OUT VOLT = 154 COUNTS x 81 mV / COUNT = 12.28 V REASONABLE

MID CURRENT W/ #311 LOAD TO STSPOS. - 128 COUNTS - 103 BASE

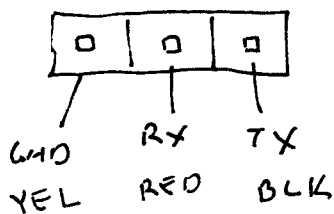
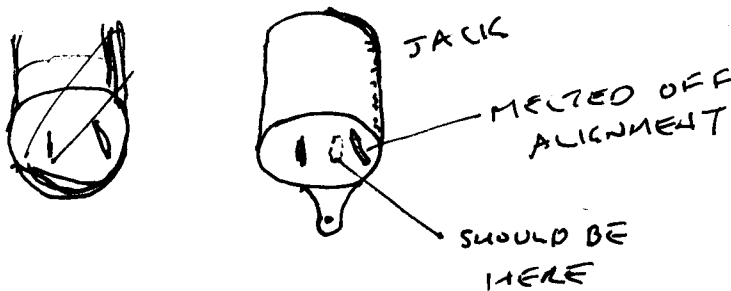
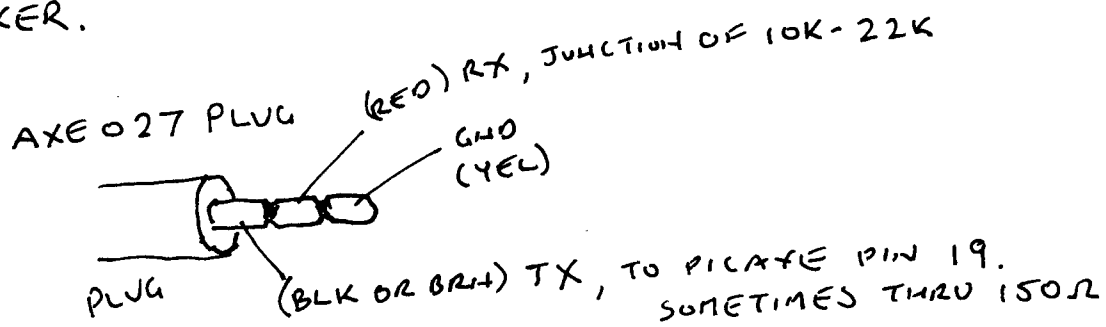
= 25 COUNTS. 25 COUNTS · 51 mA / COUNT = 1.3 A ABOUT RIGHT FOR #311 @ 24 V

ALL SENSORS EXCEPT TEMPERATURE SEEM OK. WAITING ON LM340Z FROM CHINA.

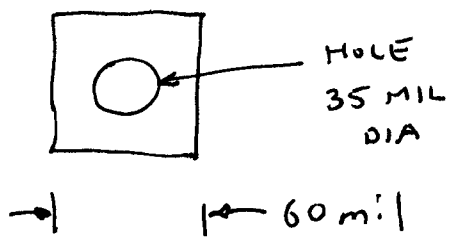
06 DEC 2015;  
Roderick.

PROGRAMMING JACK FOR PICAXE WAS HARD-WIRED (SOLDERED)  
ON BREAD BOARD. CHANGED TO 3-PIN HEADER & PLUG, AND IT  
STOPPED WORKING. FOUND THAT CHEAP STEREO <sup>JACK</sup> PLUG PLASTIC  
HAD MELTED JUST ENOUGH DURING SOLDERING SO THAT  
RX SHORTED TO GND ONLY WHEN PLUG WAS INSERTED.

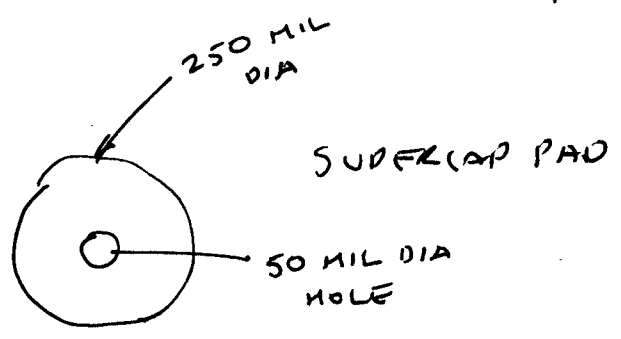
IT WAS OK WHEN NO PLUG WAS INSERTED. TOOK A WHILE  
TO SOLVE THE MYSTERY. IF I HAD PUT A SCOPE ON THE  
SIGNALS, COULD ~~BE~~ PROBABLY HAVE FOUND ROOT CAUSE  
QUICKER.



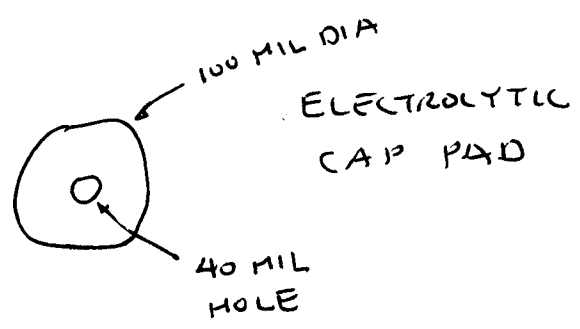
GATE WINDING HOLES ARE TOO SMALL FOR #20 WIRE,  
STRANDED.



#20 WIRE IS 32 MIL DIA, SO THEORETICALLY, IT SHOULD JUST FIT IF 35 MIL IS FINISHED HOLE SIZE. PART OF PROBLEM COULD BE MFG TOLERANCE, OR HOLE PLATING THICKER DUE TO 2oz COPPER, OR HASL SOLDER FINISH STICKING IN HOLES.



#20 WIRE FITS FINE IN THESE, BCAP LEAD DIAMETER IS 0.8mm = 32 MIL

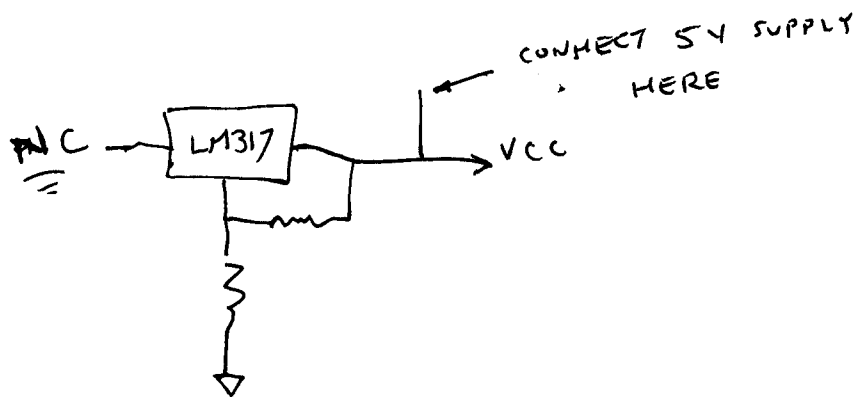


#20 FITS PERFECTLY.

OH WAIT! I SEE THAT STRANDED #20 IS 38 MILS IN DIA IF IT'S 7/28 (7 STRANDS OF #28). MAYBE I CAN JUST FIND #20 SOLID.



INPUT CURRENT SENSOR BASELINE READING.



VOLTAGE AT 14M2 SUPPLY PINS = 4.87V

INPUT CURRENT RAW READING 105 TO 106

WITH NORMAL SUPPLY, 14M2 SUPPLY VOLTAGE = 5.10V

INPUT CURRENT RAW READING 107

12 DEC 15. 5x LM35DZ FROM CHINA (EBAY) ALL BAD. CONNECTED 5 VOLTS, OUTPUT IS FLOATING. CONFIRMED MY DIAGNOSIS W/ ALLABOUTCIRCUITS.COM. FORGOT TO ORDER 0.01uF CAPACITORS FROM Mouser. CAN PICK SOME UP AT HALTED.

14 DEC 15. ENERGIZED THE FLASHER CIRCUIT. IT WORKS, BUT GOES ON-dim-off-dim... AUTO-START DROPS TO BLANK IN PART FOR PARASITIC LEAKAGE IN OFF STATE. REMOVED D9, TIED R42 DIRECTLY TO POSITIVE SUPPLY. HELPED A LOT. FLASH RATE TOO SLOW. WHAT I WANT IS A BRILLIANT FLASH EVERY 0.7 SECONDS. DOES NOT NEED TO BE A LONG FLASH. R42 CONTROLS ON TIME, R41 CONTROLS OFF TIME, WILL PUT IN PUTS TEMPORARILY TO FIND OPTIMUM VALUE.

18 DEC 15. GOT 5x LM35DZ REPLACEMENTS FROM SAN FRANCISCO (EBAY) VENDOR. ALL GOOD. PUT ONE INTO CIRCUIT. RAW READING 41 WHEN GRASPED IN FINGERS. READING WENT TO 56 PUT ICE CUBE ON TOP OF T0-92, READING DROPPED TO 29 CONCLUSION: GOOD.

18 DEC 15; Roderick.

FLASHER TIMING COMPONENTS - EXPERIMENTALLY DETERMINED.

$C40 = C41 = 10 \mu F$  ACTUALLY, COMPONENTS CLOSE TO  $7 \mu F$ ,

$R42 + C40$  CONTROL OFF TIME.  $R42 = 186 K$

$R41 + C41$  CONTROL ON TIME.  $R41 = 33K$  COULD EVEN GO LOWER

CHANGED DESIGN TO  $178K$  FOR  $R42$ ,  $20K$  FOR  $R41$ . WORKS.

31 DEC 2015. WAIT TO GET ACTUAL POWER TRANSFER WORKING TO TEST SHUTDOWN THROUGH COMPARATOR. NO NEED FOR COMPLICATED SCHEME OF GENERATING OUTPUT VOLTAGE. MAYBE SHOULD ADD A LITTLE BIT OF HYSTERESIS TO COMPARATOR?

- INSTALL GATE RESISTOR

- INSTALL MOSFET w/ SMALL HEAT SINK

- TIM B14 1K01 &  
REMOVE FROM  
BREADBOARD

- INSTALL  $1000 \mu F$  INPUT CAP

- INSTALL  $1000 \mu F$  OUTPUT CAP

- INSTALL TEMPORARY L1, WITH GATE WINDING.

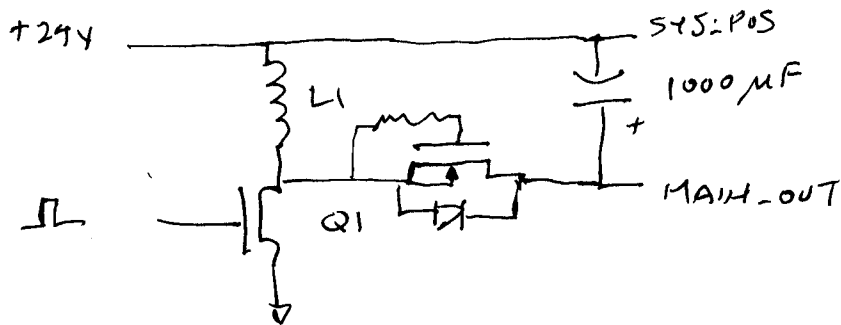
→ SINGLE PULSE TEST

→ BURST PULSE VIEW GATE ON SCOPE

05 JAN 2016. HOOKED UP ABOVE EXCEPT L1. SEE 10V PULSE GOING INTO GATE OF MAIN SWITCH. SCOPE TRIGGER ON 6022 BE UNRELIABLE - WITH TEST SOFTWARE, NEEDED TO DO  $\sim 5$  PULSES TO CAPTURE TRACE.

05 JAN 2016, Roderick.

TRYING EXPERIMENT. Q1 INSTALLED, 30μH INDUCTOR TEMPORARILY  
INSTALLED, ONE 10 μS PULSE EACH TIME PUSHBUTTON IS PRESSED.



MAIN-OUT STARTS AT 0.01V

VOLTAGE DID NOT CHANGE ON MAIN-OUT AFTER A  
FEW PRESSES. HOOKING UP SCOPE.

Q1 WAS INSTALLED BACKWARDS, REVERSED IT.

MAIN OUT SEEMS TO SETTLE AT ABOUT 0.35V, EVEN WHEN IT  
WAS PREVIOUSLY SHORTED TO 0, AND THERE IS NO PUMPING.

NOW Q1 APPEARS SHORTED. MAYBE BURNED IT OUT.

CONFIRMED. SHORTED. FPDF085N10.

07 JAN 16. REPLACED Q1 W/ TI CSD19503KCS, ORIENTED PROPERLY,  
SEEMS TO WORK.

ADJUSTED OVERVOLTAGE THRESHOLD ON COMPARATOR TO 2.08V

THIS IS A LITTLE MORE THAN <sup>40</sup>~~32~~V, AND JUST OVER THE

2.048V THAT THE PICAXE CAN READ. CORRECTION - FOR

BRING UP PURPOSES, TUNE TO 1.00 VOLT ~~SO AT~~ TO SEE IF

CIRCUIT KICKS IN AT 20V OUTPUT VOLTAGE,

↳ NO, IT'S MORE LIKE 16V

10 JAN 2016; Roderick.

CHANGED TEST PROGRAM TO OUTPUT A BURST OF PULSES FOR 10ms WHEN BUTTON IS PRESSED. OUTPUT VOLTAGE JUMPS TO  $\sim 11$  VOLTS. GOOD. USED HPWM AT FIRST, IT WORKED IN SINGLE MODE. PICAXE MANUAL DATED 10/2015 (MANUAL 2) SAYS SINGLE IS NOT SUPPORTED ON 14M2 OR 20M2, BUT IT SEEMS TO WORK, AT LEAST TO OUTPUT A. DOCUMENTATION ERROR? CHANGED CODE TO USE PWMOUT

PUSH THE BUTTON A FEW TIMES IN RAPID SUCCESSION, AND THE FLASHER STARTS TO FLASH. ERRATIC, THOUGH. MAYBE SHOULD GO BACK TO ORIGINAL FLASHER DESIGN. IF THE BOARD IS EVER SPUN, GO WITH ADDITIONAL OUTPUT BUFFER.

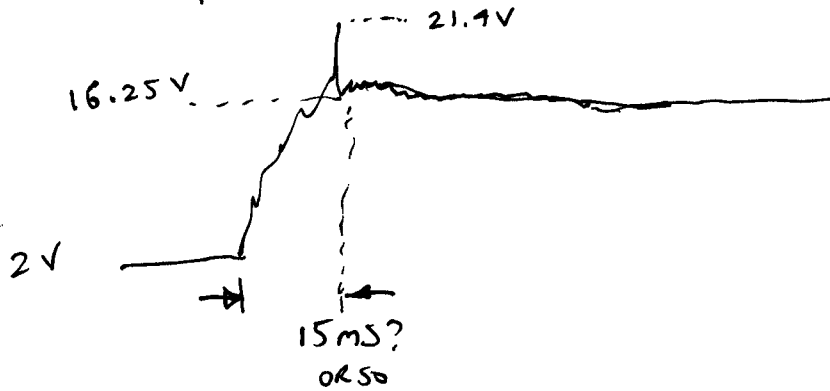
14 JAN 2016. BURST OF PULSES INCREASED TO 100ms. OUTPUT VOLTAGE SATURATES AT 201 COUNTS. LOOKS LIKE OP-AMP COMPARATOR IS DOING ITS JOB AT SHUTTING DOWN CONVERSION AT OVERVOLTAGE. THRESHOLD VOLTAGE SET AT 1.00 VOLT. AT 80-81mV/COUNT, THIS IS CONSISTENT WITH 16.8 VOLT OUTPUT.

NEXT EXPERIMENTS:

1. TURN UP THRESHOLD TO 1.5V, CONSISTENT W/ 24 VOLT OUTPUT.
2. CONTINUOUS PULSES WHILE BUTTON IS HELD DOWN.  
- SHOW INPUT VOLT, CURRENT, OUT VOLT.
3. SAME, WITH 24V LAMP ON OUTPUT (40W)

CHECKING CALIBRATION ON 6022BE SCOPE. WITH OPEN 6022BE,  
VOLTAGE READS 24.53V; DVM SAYS 24.5V GOOD.

NOW CHECK OUTPUT VOLTAGE WITH COMPARATOR THRESHOLD SET  
AT 1.00 VOLT, OUTPUT

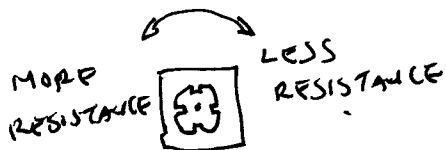


WILL SET NEW THRESHOLD AT <sup>1.50</sup>~~2.00~~ VOLTS, FOR APPROX 24 VOLT  
OUTPUT LIMIT. IN SERVICE, LIMIT WILL BE HIGHER, COMPARATOR USED  
AS EMERGENCY SHUTDOWN ONLY. IN SERVICE, LIMIT WILL BE  
MAYBE 2.1 VOLTS, THRESHOLD.  
WITH THRESHOLD SET AT 1.502 V, SEE 24.2 VOLTS ON OUTPUT.

FDPF085N10 - 31nC GATE CHARGE TYP, INPUT CAP 2025pF TYP  
FDD86326 - 13.4nC TYP, 780 pF TYP

IF I DO A REV 2 OF THIS BOARD, SHOULD ADD TEST POINT FOR  
PUMP. CHANGE SYNC RECTIFIERS TO ~~DPAK~~ P2PAK PACKAGE INSTEAD  
OF DPAK.

16JAN16. CONNECTED UP GATE DRIVE WINDOW. SYNC RECT STATING ON  
TOO LONG.



GATE RES → SOURCE = 1233 Ω  
TURNED DOWN TO 933 Ω STILL 6ms  
TURNED TO 607 Ω NO OSC. OF OSCILLATIONS  
TRY 795 Ω - 6ms OSC.  
TRY 702 Ω - CLEAN, AFTER FINAL VOLTAGE  
REACHED, 1 PULSE GETS THROUGH EVERY  
900 μS.

MLK DAY.

CHANGED TEST PROGRAM TO START STREAM OF PULSES WITH FIRST BUTTON PRESS, THEN CONTINUE FOREVER UNTIL BUTTON PRESSED AGAIN. OUTPUT VERY SPIKY, BUT SMOOTH OUTPUT WAS NEVER A DESIGN GOAL. WHEN #311 BULB IS PUT ACROSS OUTPUT, IT GLOWS DIMLY. EXPECTED. PWM SET FOR  $10\mu\text{s ON} / 64\mu\text{s PERIOD}$ .

$L_1$  (TEMPORARY INDUCTOR)  $\approx 25\mu\text{H}$ . SUPPLY VOLTAGE  $\approx 25\text{V}$ .

SO CURRENT  $\approx 1\text{A}/\mu\text{s}$ .  $10\mu\text{s} \rightarrow 10\text{A}$ . ENERGY =  $\frac{1}{2} L I^2 =$

$$0.5 \times 25 \times 10^{-6} \times 10^2 = 12.5 \times 10^{-4} = 1.25 \times 10^{-3} \text{ J}, \quad 64\mu\text{s IS}$$

ABOUT 16 KHZ.  $16 \times 1.25 \times 10^{-3} \times 16 \times 10^3 = 20 \text{ W}$ . ABOUT RIGHT -

BULB IS NOMINAL 37W, Q1 NEVER GOT EVEN WARM.

PRESENT SETTINGS FOR PWMOUT:

PWMOUT PUMP\_PIN, PERIOD, DUTY

$$\text{PERIOD} = 255 \quad \text{DUTY} = 160$$

WANT 40A PEAK PULSE, SO  $40\mu\text{s}$ . IF USE PWM DIV 16 PRESCALER,

THAT WOULD BE DUTY OF  $160 \cdot 4 / 16 = 40$ . FOR 50% DUTY

CYCLE, PERIOD = 20, BECAUSE BUILT IN EXTRA 4x PRESCALER

FOR PERIOD. ENERGY PER PULSE IS 16x PREVIOUS CALCULATION,

OR  $20 \times 10^{-3} \text{ J}$ , PERIOD IS  $80\mu\text{s}$ .

$$\text{POWER} = \frac{20 \times 10^{-3}}{80 \times 10^{-6}} = \frac{1}{4} \times 10^3 = 250 \text{ W IN THEORY.}$$

BUT PANEL CAN'T SUPPLY 250W, OF COURSE.

MINIMUM POWER AT THAT PULSE WIDTH,  $\frac{20 \times 10^{-3}}{4096 \times 10^{-6}} = \frac{20}{4,096} \overset{\text{ABOUT}}{=} \frac{5 \text{ W}}{10}$

WOULD HAVE TO GO TO SLOWER CLOCK TO GET LESS.

SET TEST PROGRAM FOR

PWMOUT PMMDIV16, PUMP\_PIN, <sup>63</sup>~~20~~, 40.

#311 BULB BURNS AT FULL BRIGHTNESS. MORE EFFICIENT THAN I THOUGHT? Q1 DOES ~~SEE~~ (STILL) DOES NOT EVEN GET WARM,