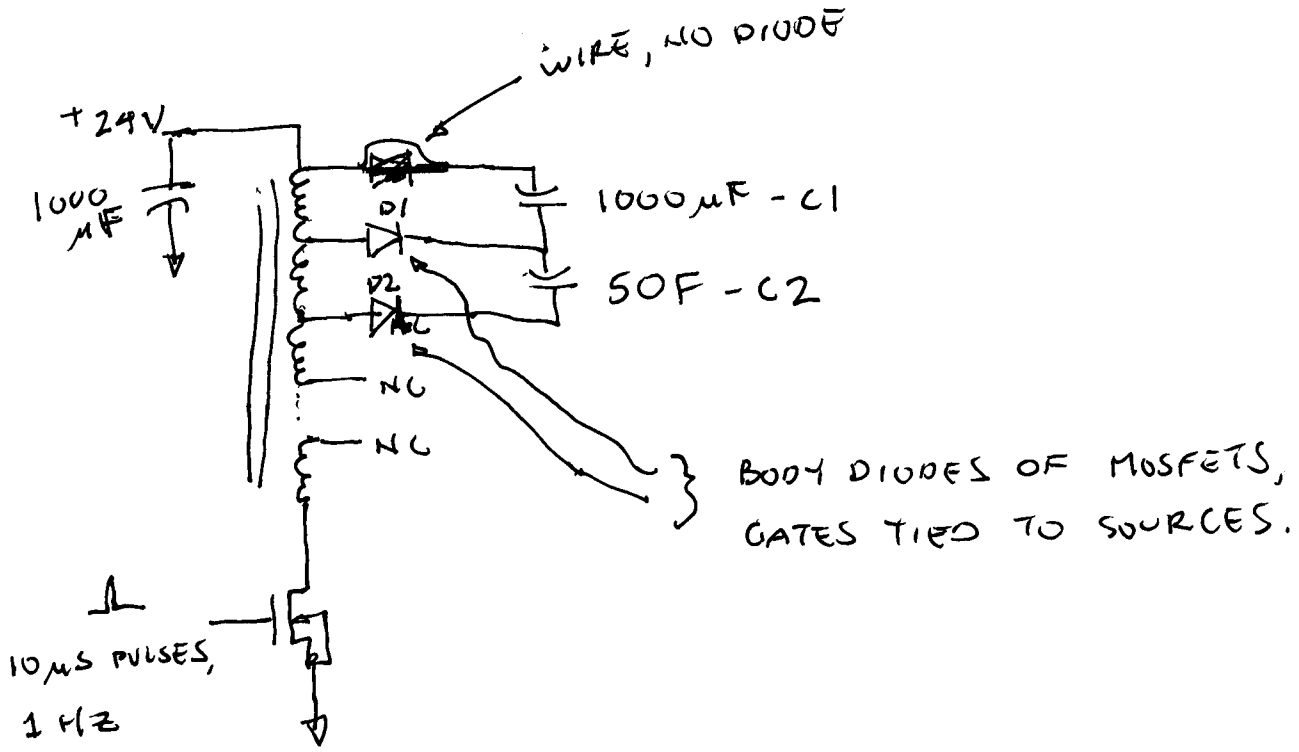
19 JUL 2015; Roderick.

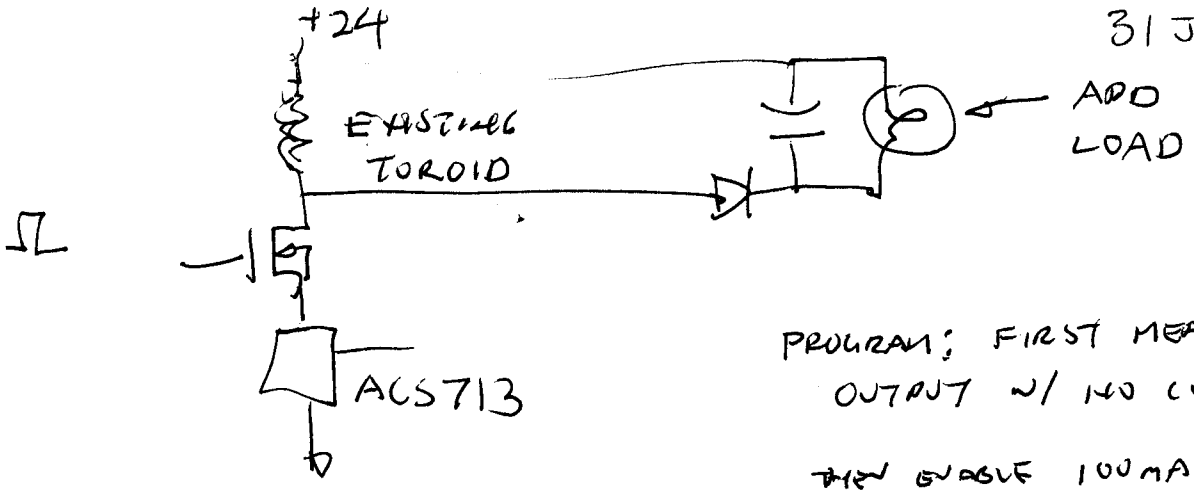
ON 14 JUL, JUST BEFORE HAWAII TRIP, RAN THIS EXPERIMENT:



AFTER A FEW SECONDS, END UP SEEING 7V ACROSS C1, 0.15V ACROSS C2. NOT GOOD. WHEN VOLTAGE ACROSS C1 IS TOO HIGH, D1 MAY NOT BE CONDUCTING, BUT D2 WILL BE. CURRENT STILL HAS A PATH THROUGH BOTH C1 AND C2, AND WILL CHARGE CAPS UNEQUALLY. GOOD THING THAT JUST BY DOG LUCK, I PUT THE SMALLER CAP WHERE I DID. IF I PUT THE BIG CAP AT THE TOP, MAY HAVE SEEN 0.15V ACROSS BOTH, AND ASSUMED EVERYTHING OK.

SYNCHRONOUS RECTIFICATION MAY HELP BY ALLOWING DISCHARGE OF TOP CAP (AND EVEN RECYCLING THE ENERGY). WILL HAVE TO EXPERIMENT LATER.

31 JUL 2015



PROGRAM: FIRST MEASURE OUTPUT W/ NO CURRENT

THEN ENABLE 100 MA AVG CURRENT.

ADD TESTPOINTS TO SCHEMATIC

1206	HOLE
MOTOR +	EXTRA PINS ON 2012
SOLAR +	~~GROUND~~ LOGIC_GND
VDRIVE	
VCC	
LOGIC_GND	
PUMP	
MAIN SWITCH DRAIN	

31 · JUL · 2015; Roderick,

REWORKED DESIGNSPARK SCHEMATIC WHILE IN HAWAII,

ADDED TEMPERATURE SENSOR. LM340Z

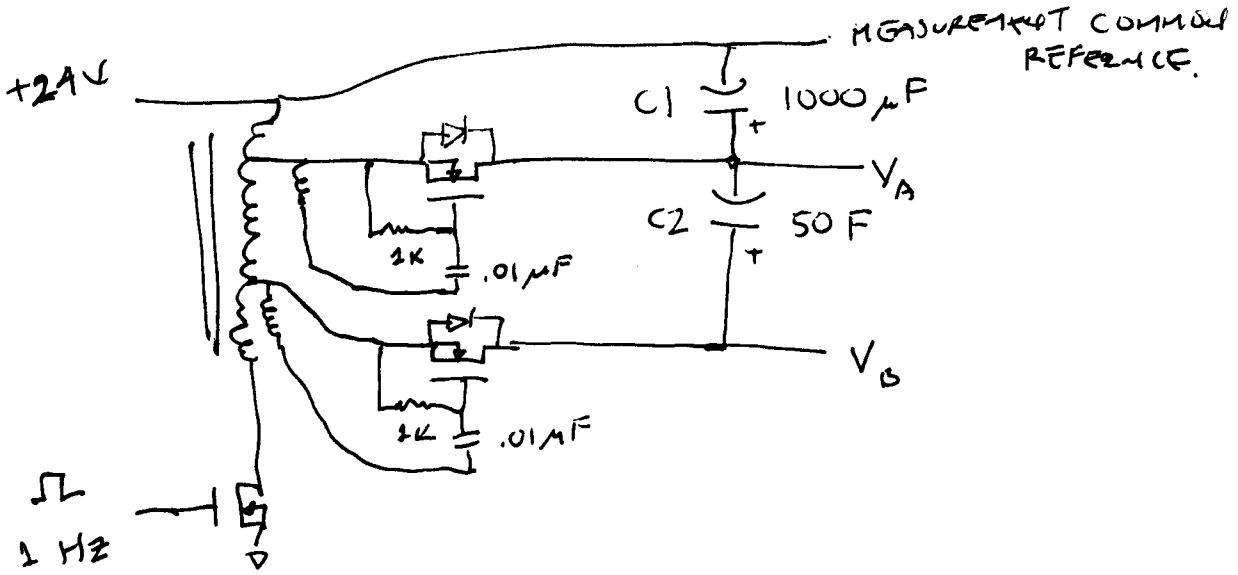
MOVED OUTPUT CURRENT SENSOR TO BE SENSOR FOR CURRENT ON MAIN SWITCH.

RENUMBERED REFERENCE DESIGNATORS.

DID AUTO PLACEMENT. LOOKS LIKE DESIGN FITS IN 8"x8" AREA - MAYBE 7.5"x7.5"

03·AUG. 2015;
Roderick.

RAW EXPERIMENT



V_B QUICKLY ZOOMED UP TO ~6.05 V

V_A AT 6.03V OR SO

V_B ~~STEADY~~ ONLY VERY SLOWLY CLIMBING.

THEORY: UP TO ~~6~~ $V_B = 6V$, SYNCRONOUS RECTIFIERS NOT TURNING ON. BODY DIODES ALLOW UNEQUAL CHARGE TO THAT ~~POINT~~.

IN FACT, IN PREVIOUS EXPERIMENT W/ JUST BODY DIODES, V_A GOT TO 7 VOLTS QUICKLY.

CHANGED C2 TO 2200μF. $V_A = 6V$, $V_B = 4V$. NOT EXACTLY EQUAL, BUT CLOSER.

SUGGESTS SYNC RECTIFIERS HAVE VERY LITTLE EFFECT.

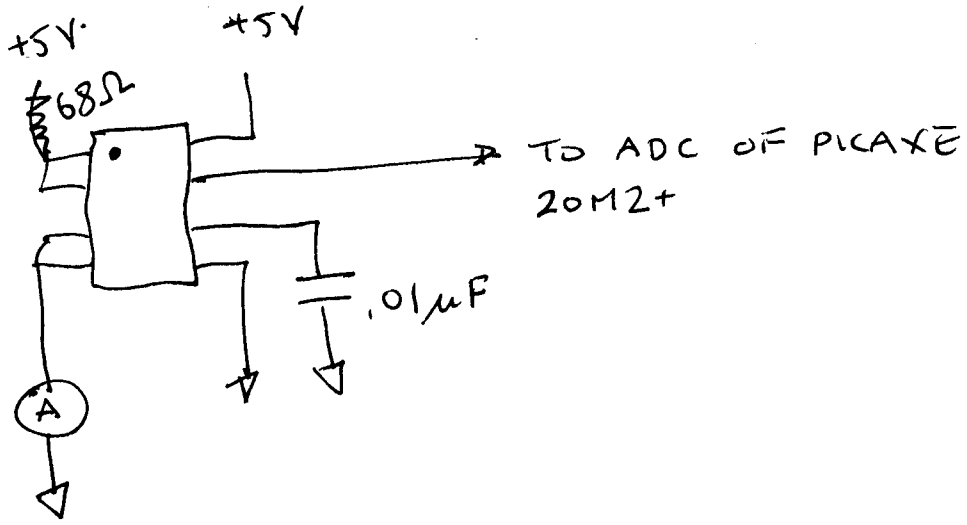
IF $E = \frac{1}{2}CV^2$

$\frac{1}{2} \cdot 1000 \cdot 6^2 = 18,000$

$\frac{1}{2} \cdot 2200 \cdot 4^2 = 17,600$

16 AUG 2015;
Roderick,

ACS 713 TEST



QUIESCENT VOLTAGE AT OUTPUT ABOUT 0.59 V WITH ZERO CURRENT IN. ADC READS 107 OR 108.

CONNECT 68Ω RESISTOR. CURRENT AS MEASURED BY METER IS ~~62~~ 67 mA. $\frac{5}{68}$ = ~~0.073~~ 0.073 ABOUT RIGHT.

ADC READING IS ABOUT 110. IF FULL SCALE IS 5 VOLTS, EACH COUNT IS ~ 5 mV. SENSITIVITY OF ACS713 IS 185 mV/A TYPICAL. 185 x .067 = 12.4 mV

ABOUT 2-3 COUNTS. WITHIN NOISE, LIMITS. TRY USING ULTRAFIRE AA BATTERY, SHORT CIRCUIT CURRENT, QUIESCENT COUNT = 106 TO 107.

4 AMPS, COUNT = 250 (STARTED AT 273, BATTERY DRAINS FAST)

4A x 185 mV/A = 740 mV CHANGE IN COUNT = 250 - 106 = 144

$\frac{144}{1024}$ x 5V = 703 mV CLOSE ENOUGH.

NEXT TEST IS TO SEE HOW IT DOES WITH PULSING CURRENT.

26 AUG 2015; Rodarick.

WHAT IS THE BEST HOLE SIZE FOR A TEST POINT?

DVM PROBE TIPS ARE 1/16" DIA, SO HOLE SHOULD BE SMALLER THAN THAT (0.0625"). #16 WIRE HAS A DIAMETER OF .051", SO WOULD LIKE TO GO BIGGER THAN THAT FOR GATE DRIVE WINDING HOLES, AND TEST POINTS COULD BE THE SAME.

#53 DRILL W/ 3 MIL PLATING ALLOWANCE RESULTS IN 0.056" FINISHED HOLE SIZE. WILL USE THAT. OR MAYBE SHOULD MATCH SIZE OF HOLES FOR CAPS OR DIPS? OR HEADERS?

PART	HOLE SIZE (MIL)
DIP-20	32
PHOENIX CONNECTOR	60
1000μF CAP	40
50F CAP	50
TO-220 (LM317)	60
LED	30
LM34 (TO-92)	32
MAIN INDUCTOR	86
HEADER, 3 PIN	35

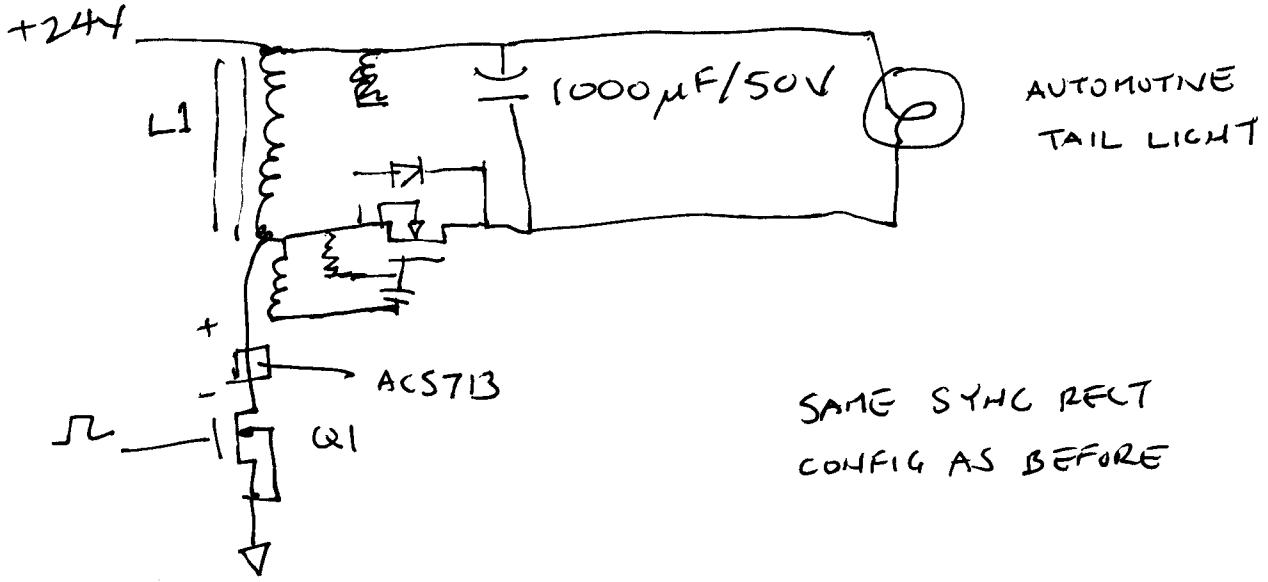
GATE WINDING HOLE - 35

1206 TEST POINT IS JUST A SURFACE MOUNT.

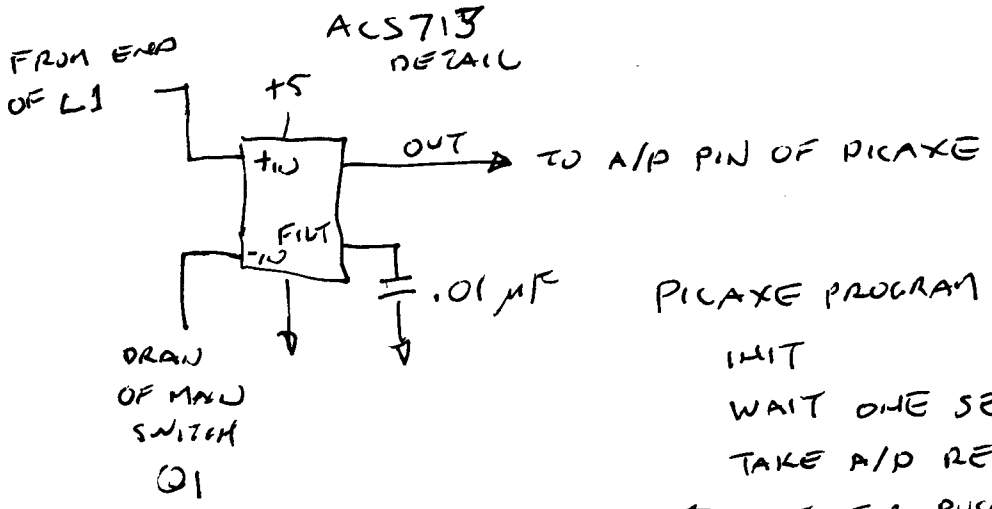
→ CHANGE THROUGH-HOLE TEST POINTS TO 32 mil HOLE.
CHANGE LED TO ~~32 MIL ALSO~~ .35 MIL TO ACCOMODATE 0.1" SQUARE POST HEADERS IF DESIRED.

30·AUG·2015; Roderick.

TEST OF ACS713 WITH PULSING CURRENT > 20A



SAME SYNC RECT CONFIG AS BEFORE



PICAXE PROGRAM

INIT
WAIT ONE SECOND
TAKE A/D READING - PRINT
WAIT FOR PUSHBUTTON
START PULSOUT
WAIT HALF SECOND
TAKE A/D READING - PRINT
STOP PULSOUT
WAIT FOR PUSHBUTTON RELEASE
GO TO

03-SEP-2015; Roderick

TRYING PULSED CURRENT ACS713 EXPERIMENT.

BAUD RATE OF TERMINAL NEEDED TO BE ADJUSTED. 38.2 kBAUD WAS FOR 32 MHz. NEED 19.6 kBAUD.

HAD WIRED TO ADC PORT B.2 INSTEAD OF B.1 AS IN PROGRAM.

FIXED ABOVE ISSUES, RAN PROGRAM WITHOUT 24V SUPPLY CONNECTED, GETTING READINGS OF 107 ADC COUNTS.

~~CORRECT~~ TURNED ON 24V SUPPLY. PUSH BUTTON

COUNT BEFORE = 107 COUNT AFTER = 112

BULB WENT ON FOR HALF A SECOND. FELT HEAT SINK OF MAIN SWITCH - STILL COLD.

THAT'S WAY LESS CURRENT THAN EXPECTED. 5 VOLT SUPPLY, ~~1024 COUNTS, 5/1024~~ = 1023 COUNTS. $5/1023 = 4.89$ mV / COUNT

185 mV/A ON CURRENT SENSOR. THEN EACH COUNT IS $4.89/185 =$ ~~0.26~~ 0.0264 A SO 5 COUNTS = 5 * 26.4mA = 132 mA

CAN'T BE RIGHT, GIVEN THAT BULB WAS GLOWING BRIGHT,

THEORY: 0.01μF C_F FILTER CAP IS NOT ENOUGH.

INTERNAL RESISTANCE OF ACS713 FOR TIMING CONSTANT PURPOSES IS 1.73 kΩ. $1.73 \times 10^3 \times .01 \times 10^{-6} = 17.3 \times 10^{-6}$

ABOUT 17μS TIMING CONSTANT. PERIOD OF PWM IS 64μS, SO DEVICE MAY JUST HAVE MEASURED AN OFF PERIOD,

BECAUSE RESPONSE TIME SO SHORT.

WILL TAKE MULTIPLE MEASUREMENTS, BUT EVEN IF REPEATABLE, WILL CHANGE DELAY BEFORE MEASURING. CLOCK IS 16 MHz. EACH mS EXTRA IS 16,000 CLOCKS. EACH PERIOD IS 1024 CLOCKS. OR EACH mS IS 1000 μS, EACH PERIOD IS 64 μS. SINCE THERE IS A 16 MHz CLOCK, CAN ACTUALLY SPECIFY A DELAY OF 1 AND IT WILL BE 0.25 ~~mS~~ mS = 250 μS.

250 mod 64 ≡ 58 (OR -6). SO ~~ADD EACH EXTRA COUNT IN~~ PAUSE STATEMENT

SO EACH EXTRA COUNT IN THE "PAUSE" STATEMENT OFFSETS THE PHASE OF MEASUREMENT BY ~6 µS WITHIN THE 64 µS PERIOD.

CLOCK = m16 (16 MHz)

PAUSE AFTER STARTING PWM	PERIOD	DUTY	A/D ACS713 MEASUREMENT BEFORE PWM	A/D ACS713 MEASUREMENT "AFTER" (COUNTING) PWM
2000	255	160	107	112
			106	124
			106	118
			107	112
			107	131
2001	"	"	107	111
			106	153
			108	116
2002			107	113
			107	117
			107	118
2003			106	114
			108	123
			106	124
2004			105	121
			106	118
			107	121
2005			107	126
			106	130
			107	131
2006			107	139
			107	153
			107	173

CONTINUED NEXT PAGE

04SEP 2015; Roderick

PAUSE AFTER STARTING PWM	PERIOD	DUTY	ACS713 OUTPUT RAW A/D READING BEFORE PWM	DURING PWM
2007	255	160	106	173
			105	167
			106	113
2008			106	179
			107	113
			107	177
2009			108	141
			107	123
			107	139
2010			108	114
			107	125
			108	155
			107	123
			106	149
2011			108	112
			106	144
			107	116

THERE DOES SEEM TO BE MORE CURRENT IN SOME PHASES.
NOW INCREASE CF TO 1μF, MAKING TIME CONSTANT 1.7 mS

2011			107	132
			107	132
			107	132
2002			106	132
			107	132
			107	132
2008			107	133
			107	132
			107	135
2008 w CF REMOVED			~107	MOSTLY 110, SOME PEAK 272

10 SEP 2015; Roderick.

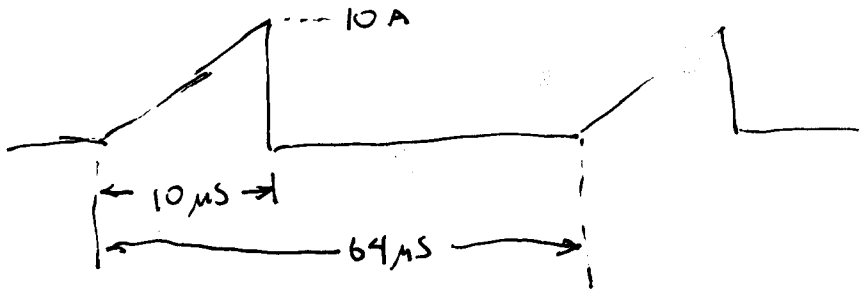
PUT SCOPE ON +24V SUPPLY CAPACITOR TO SEE IF SUPPLY WAS DROOPING WHEN INDUCTOR CHARGING. YES, IT DIPPED TO +20V, ACTUALLY, SPIKED DOWN BRIEFLY.

IS THE READING OF 132 IN EXPERIMENT REASONABLE?

132 - 107 = 25 COUNTS NET. 0.0264 A/COUNT.

0.0264 × 25 = 0.66 A

HOW MUCH SHOULD IT BE?



AVERAGE CURRENT WHEN FLOWING = $\frac{1}{2} \cdot 10 = 5$ A

DUTY CYCLE = $10/64 = 0.15625$

AVERAGE CURRENT = $5 \cdot 0.15625 = 0.78$ A

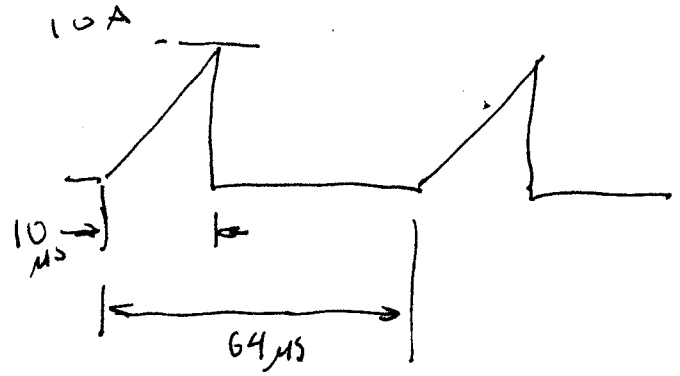
SO THE READING IS ABOUT 15% LOW. CAN PARTLY BE ACCOUNTED FOR BY DIP IN SUPPLY VOLTAGE.

NOW TRY REDUCING FUNDAMENTAL CLOCK TO 4 MHZ. THAT PUTS PEAK CURRENT AT 40 A, THEORETICALLY, AND AVERAGE CURRENT AT 4× PREVIOUS.

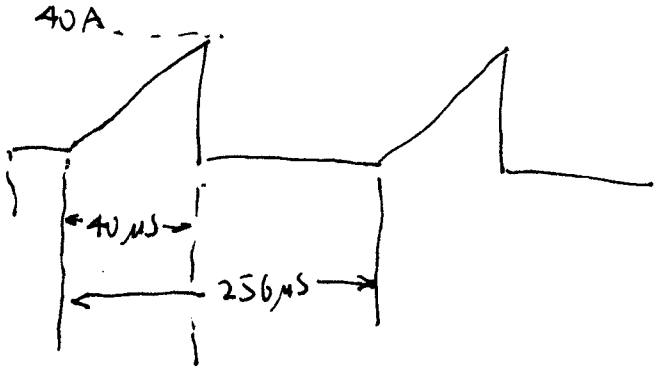
READINGS BEFORE 107 DURING 188

LAMP <u>REALLY</u> BRIGHT.

14SEP2015,
Roderick.

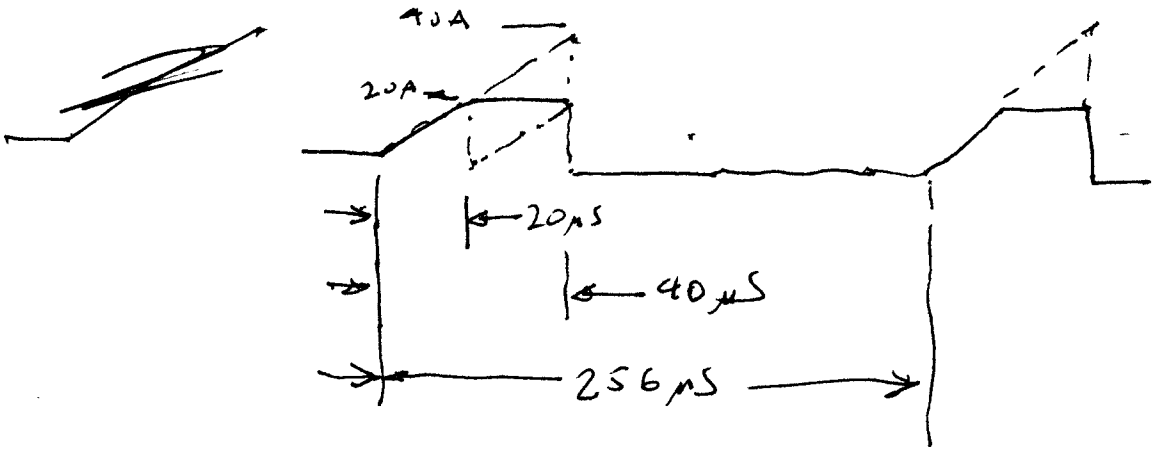


EXPERIMENT AT
16 MHz
SYSCLK



@ 4 MHz SYSCLK,
4X THE CURRENT
AT PEAK

IDEALLY, READING SHOULD BE 4X THE PREVIOUS AVERAGE.
IT IS NOT. BUT SUPPOSE CURRENT SENSOR READING CLIPS
AT 20A. READING WOULD BE LIKE



OR 3X THE PREVIOUS READING.

16 SEP 2015; Roderick.

A/D READING @ 16 MHz = 132 - 107 = 25

" " @ 4 MHz = 188 - 107 = 81

NEW READING SHOULD IDEALLY BE 4X THE OLD ONE OR 100, MEANING AN END READING OF 207.

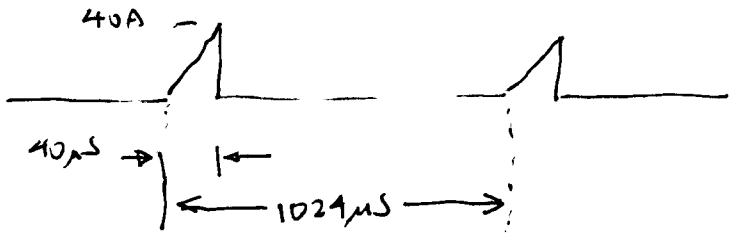
FACTOR	HIGHER OR LOWER @ 4 MHz	DISCUSSION
LOWER SWITCHING LOSSES IN MOSFET	+	NEGLIGIBLE AT FREQ. OF 16 → 4 kHz
CANNOT +24V 1000 μF CAPACITOR CANNOT REFILL FAST ENOUGH TO SUPPORT 40A PEAK	—	$\frac{1}{2}LI^2 = .5 \times 24 \times 10^{-6} \times 40^2$ $= 12 \times 16 \times 10^{-4}$ $= 192 \times 10^{-4} = 1.92 \times 10^{-2}$ $\frac{1}{2}C(24^2 - V_{FINAL}^2) = 1.92 \times 10^{-2}$ $500 \times 10^{-6}(576 - V_{FINAL}^2) = 1.92 \times 10^{-2}$ $(576 - V_{FINAL}^2) = \frac{1.92 \times 10^{-4}}{.5 \times 10^{-3}}$ $= 3.84 \times 10^{-1}$ ⇒ V_{FINAL} DOESN'T DROOP MUCH
24 V SUPPLY CANNOT SUSTAIN REQ'D CURRENT	—	$I_{AVG} = \frac{40A}{2} \times \frac{10}{64} = \frac{25}{8} = 3.25A$ SUPPLY ONLY RATED FOR 2A OUTPUT CURRENT SUGGESTS INPUT IS $3/4 \cdot 3.25 \approx 2.4A$, WHICH IS ASWT EXPECTED.
ACS713 PEGGING AT 20A, DOES NOT AVERAGE IN PEAKS ABOVE THAT	—	UNLIKELY, ALTHOUGH RESULT IS CLOSE. IF ACS713 ACTUALLY REGS AT 20A, EXPECTED NET COUNT IS 75, CLOSE TO 81.

17SEP15 ; Roderick.

CHANGED EXPERIMENT TO USE PWMDIV4 IN PWMOUT ON PICAXE.

WANTED SAME 40μS PULSE AS BEFORE, LEADING TO 40A PEAK CURRENT, BUT LOWER DUTY CYCLE. USING 4 MHz SYSTEM CLOCK.

PWMOUT, PWMDIV4, PIN1, 40, 255



RESULTS:	START COUNT	END COUNT	DIFF
	106	125	
	106	121	
	107	126	
	106	120	
	107	127	

1μF FILTER CAP ON ACS713 IS TOO SMALL AT THIS SPEED.

CHANGED TO 68μF TANTALUM...

107	125	DIFF ≈ 18
106	125	
107	126	
107	124	
106	126	

TRY 4.7μF TANTALUM...

106	125
107	126
107	125
107	123
107	125

18 SEP 15 ; Roderick

PREVIOUS EXPERIMENTS w/ 10 μS PULSE, 64 μS PERIOD, YIELDED RAW A/D COUNT OF 25.

MOST RECENT EXPERIMENT WAS 40 μS PULSE, 1024 μS PERIOD.

4X THE CURRENT, $\frac{1}{4}$ THE DUTY CYCLE.

SHOULD BE SAME AVERAGE CURRENT.

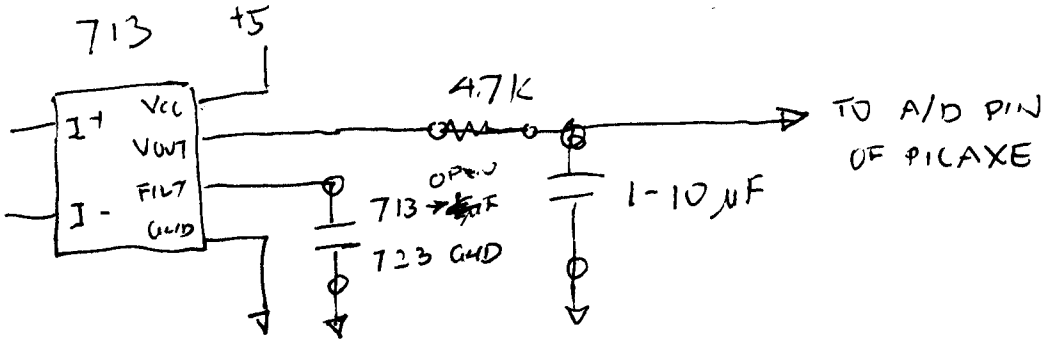
BUT READING IS 18, ALMOST PRECISELY 3/4 OF PREVIOUS.

THIS SUGGESTS THAT THE ACS713 IS CLIPPING AT 20A.

CAN GET A PART THAT ~~MEASURES~~ HAS A RANGE TO 30A.

IDEALLY, SHOULD HAVE A PART THAT DOES 40A OR MORE.

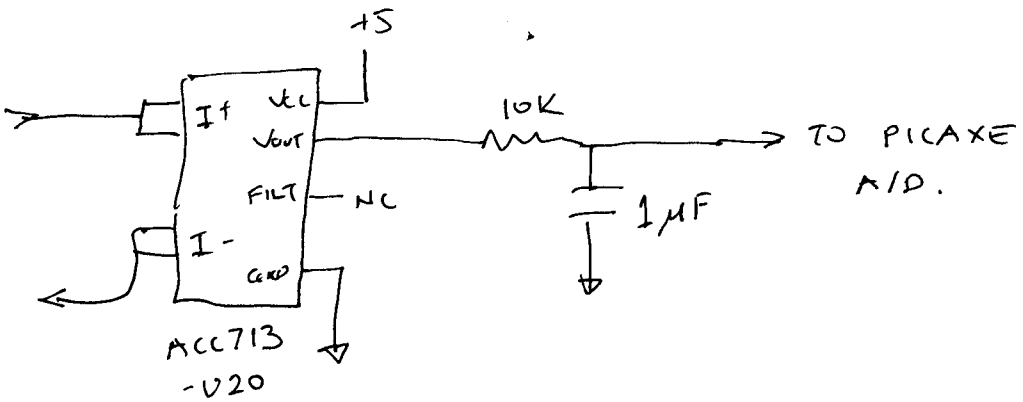
19SEP15. WILL GO TO ACS723, WHICH HAS A UNIDIRECTIONAL VERSION WITH 40A RANGE. CAN MAKE FOOTPRINT TO ACCOMODATE EITHER 713 OR 723.



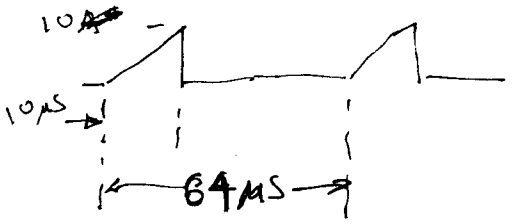
723 HAS 100mV/A OUTPUT. AFTER FILTERING, WOULD EXPECT 0 → 10A AVERAGE CURRENT TO YIELD 0.5V → 1.5V AT OUTPUT. PERFECT FOR PICAXE USING 2.048V INTERNAL REFERENCE.

19SEP2015; Roderick.

TRYING THIS CIRCUIT



OBJECT IS TO SIMULATE ACC723, SINCE I HAVE NONE ON HAND.



BEFORE READING	AFTER READING
107	131
107	132
107	130
107	131
107	131

CONSISTENT WITH PREVIOUS READINGS.

GOOD TO GO TO LAYOUT.

NEED TO CHECK ALL FOOTPRINTS.