17MAY14; Roderick

ULTRA CAPACITORS INSTEAD OF BATTERIES.
VERY LIGHT, BUT NOT MUCH ENERGY.

SUPPOSE 50 F CAPACITORS, STRUNG OF 12 PAIRS OF 2 IN PARALLEL. 27A MAX CURRENT, THAT'S WHY NEED TWO.

TOTAL CAPACITANCE = $\frac{50 \cdot 2}{12} = \frac{50}{6} = \frac{25}{3} = 8.3\,F$

WORKING VOLTAGE 2.5 V EACH CAP, SO FOR STRING, 30 V

SUPPOSE DISCHARGE FROM 30V TO 20V.

$E = \frac{1}{2} C V^2$ @ AT 30V = $\frac{1}{2} C (30^2)$
AT 20 V = $\frac{1}{2} C (20^2)$

ENERGY AVAILABLE = $\frac{1}{2} \cdot 8.3 \cdot (900 - 400)$
= 2075 J 2 SECONDS @ 1 kW.

MAXWELL BCAP0050-P270 - ±20% TOLERANCE. DON'T WANT -20/+80, HARD TO EQUALIZE
~~MAXELL~~ ULTRACAPS ABOUT $5 EACH, THAT MAKES $120 FOR THE PACK, NOT COUNTING CONSIDERABLE PC BOARD COST PLUS ANCILIARY COMPONENTS. MUST ASK MYSELF, DO I REALLY WANT TO RUN BATTERYLESS?

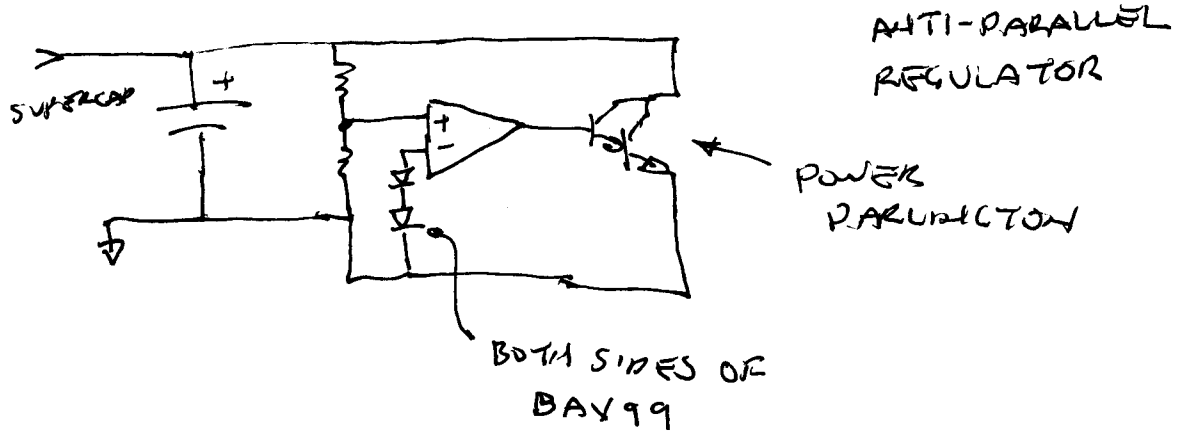
- VEHICLE WAS NEVER INTENDED TO BE PRACTICAL, NEED NOT CONSIDER COST, NOR MANUFACTURABILITY
- WOULD LEARN ABOUT ULTRACAPS IN PROCESS
- WOULD I WANT TO TAKE IT ACROSS DEATH VALLEY?
- ENOUGH FOR DEMO ON STAND
- BATTERY NOT ~~BE~~ MUCH BETTER THAN CAP ON LONG TRIP - STILL MUST RECHARGE.

24 MAY 2014
Roderick.

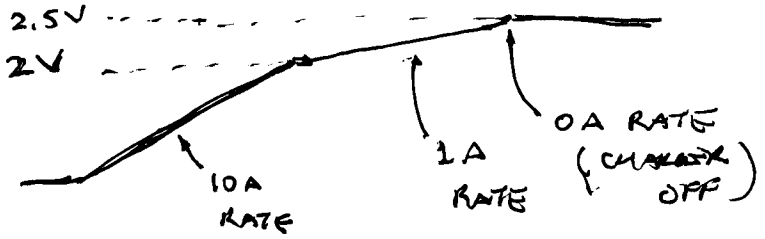
SUPERCAP EQUALIZATION CIRCUIT.

NOT WORRIED ABOUT THROWING AWAY POWER - HAVE CONSTANT SUPPLY FROM SUN.

~~AS COLLECTED~~



IDEALLY, CHARGE STACK OF CAPS AT MAX RATE, BUT WHEN IT GETS CLOSE TO ~~A~~ VOLTAGE WHERE ANY SHUNT COULD ACTIVATE, SLOW CHARGING RATE SO WON'T BURN OUT DARLINGTON. WHEN FINAL VOLTAGE IS REACHED, TURN OFF CHARGER.



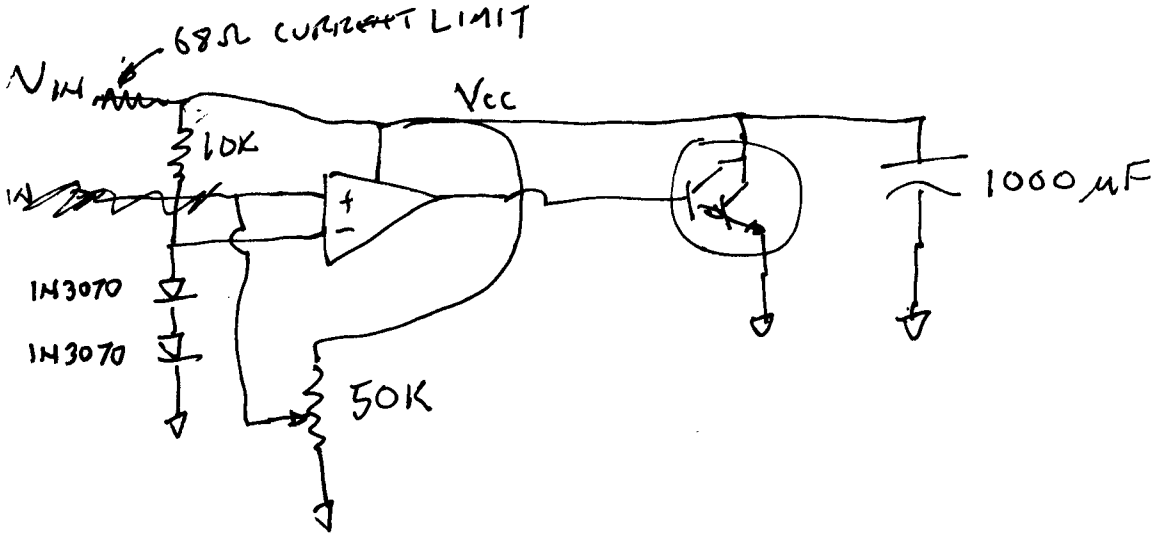
BEST DARLINGTON SEEMS TO BE MJD122G - ~~NO BASE-EMITTER RESISTOR BUILT-IN~~ → OH YES IT HAS, DPAK FOR SURFACE MOUNT, TYPICAL GAIN = 2500, AT BASE CURRENT OF 2mA, $V_{CE}(SAT) = 1V$, FOR $I_C = 2A$

FOR OP AMP, USE MCP6001. $V_{DD} = 1.8V$. SOT23-5. DOES NOT COME IN DIP, BUT MCP6002 IS DUAL UNIT IN ~~PDIP~~ PDIP-8, GOOD FOR PROTOTYPING.

26 MAY 2014; Roderick.

WANT TO PROTOTYPE CAPACITOR EQUALIZATION BEFORE INVESTING IN 25 x $5 SUPERCAPACITORS. $5 SHIPPING FROM MOUSER EVERY TIME, BUT OM SAYS BETTER TO PAY THE $5 THAN RISK $125 BUYING WRONG THING.

BEFORE EVEN ORDERING, WILL PROTO W/ LM358. NO LOW VOLTAGE OP-AMPS AVAILABLE AT RETAIL STORES, SO WILL GO WITH THAT 3V OP-AMP, AND AIM FOR TARGET REGULATION AT 4V.



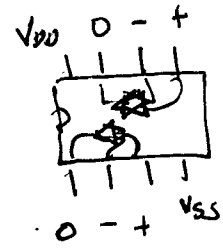
DIODES ARE NOT VERY CONSTANT VOLTAGE. AT V_{IN} = 2.0V, DIODE DROPS ARE 1.0V. AT V_{IN} = 2.7V, DIODE DROPS ARE 1.06V. @ V_{IN} = 2.5V, DROP = 1.04V. GOOD ENOUGH FOR PURPOSE, THOUGH. ONLY MATTERS THAT DIODE IS MORE CONSTANT THAN RESISTIVE DIVIDER. V_{IN} = 4V, DROP = 1.09V. INPUT VOLTAGE CHANGED 100%, DIODE CHANGED 9%. SURE ENOUGH, COMPARATOR OUTPUT GOES TO ~3V AS SOON AS SUPPLY VOLTAGE = 4.0. AT 3.9V, COMPARATOR OUT = 0. NO OUTPUT FROM COMPARATOR EVEN @ SUPPLY = 1.1V. VERY GOOD REGULATOR, ~~V_{DROP}~~ V_{CC} STAYS AT 4V WHEN INPUT SUPPLY IS 5V.

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

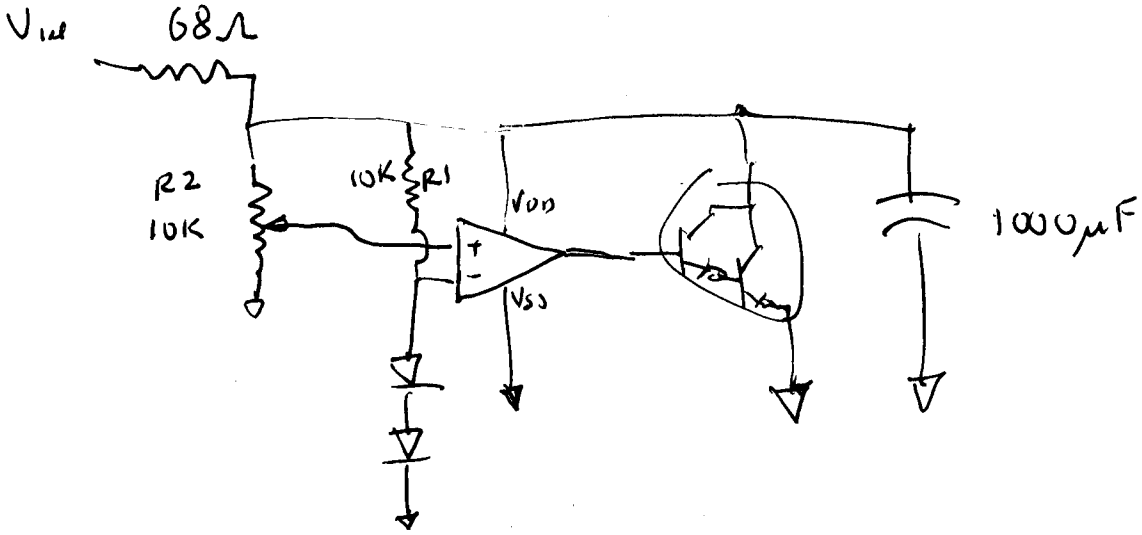
31 MAY 2014 ; Roderick

GOT MOUSER PARTS. WILL TRY REAL EQUALIZER CIRCUIT NOW.
MJD122G IS SMALLER THAN I EXPECTED. IT'S A DPAK, NOT DPAK-2.

MJD122G



MCP6002
SAME PINOUT AS
LM358



SET POTENTIOMETER R2 FOR 2.5V OUTPUT VOLTAGE.
SEEMS STABLE ACROSS RANGE OF 2.5V ~ 6V = V_{IN}

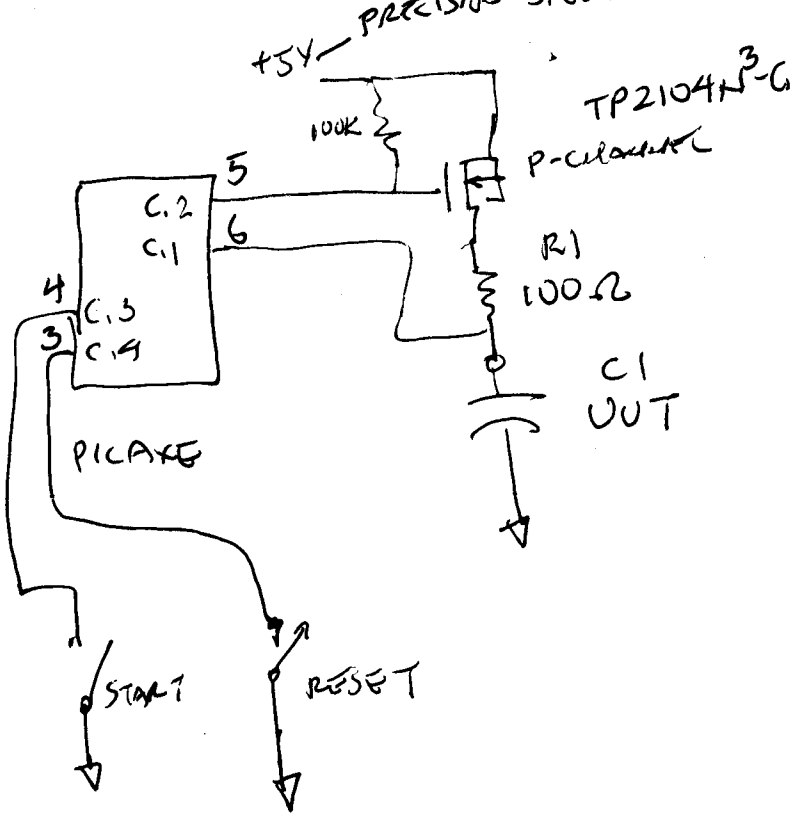
TRY CHANGING R1 TO 100K. NOW OUTPUT IS 1.94V.
RESET R2 FOR 2.5V OUT. REGULATION GOOD OVER
2.5V - 6.6V RANGE.

⇒ SHOULD TEST LATER HOW DIODE V_F CHANGES
WITH TEMPERATURE.
WARM ROOM, SEEING 2.39V NOW. WILL CHECK AGAIN
WHEN IT GETS COLD.
COOL MORNING - 2.53V
SHOULD SET CIRCUIT FOR 2.7V AT COLDEST POSSIBLE
TEMPERATURE. WHEN HOT, CAPS RATED FOR LOWER VOLTAGE,
ANYWAY.

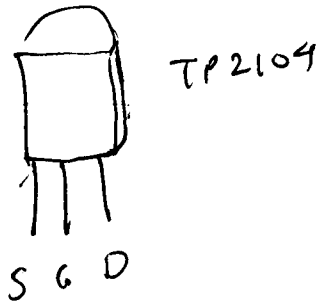
04JUN14 TRIED EQUALIZER W/ REAL 50F CAPACITOR. SEEMS TO WORK.

03JUN 2014, Roderick.

CAPACITANCE MEASUREMENT OF 50F CAPACITORS.



PROGRAM SAMPLES ONCE PER SECOND UNTIL



BEFORE USING REAL SUPERCAP, TEST PROGRAM AND CIRCUIT USING R1 = 10kΩ, C1 = 1000μF

TIME CONSTANT SHOULD BE 10 SECONDS. → LOOKS OK.

TRYING CAPACITOR 1. 100Ω = R1 V_{DD} = 5.0 V

TIME = 4461 SEC

$V = 5.0\left(1 - e^{-t/RC}\right) = 2.5$

$0.5 = 1 - e^{-t/RC}$ $\quad e^{-t/RC} = 0.5$ $\quad -t/RC = \ln(0.5)$ $\quad \frac{t}{RC} = \ln(2)$

$C = \frac{t}{R\ln(2)} = \frac{t}{100.} = \frac{t}{69.3}$ FIRST CAP = $\frac{4461}{69.3} = 64.4\,F$

IF R_{ON} OF MOSFET = 6Ω, THEN CAP IS REALLY $\frac{100}{106} \cdot 64.4 = 60.7\,F$

SECOND CAPACITOR t = 4373 SEC. ⇒ C = 63.1 F

OR 59.5F IF 106Ω ASSUMED.

CAPACITORS ARE WITHIN 2% OF EACH OTHER, ENCOURAGING.