21 OCT 13; Roderick

I NOW THINK THAT HEATING OF PROTOTYPE MOSFET IS DUE TO SLOW TRANSITIONS. SWITCHING POWER IS PROPORTIONAL TO I_{OUT}, WHILE CONDUCTED POWER IS PROPORTIONAL TO $(I_{OUT})^2$. CRUDELY.

IRFB4110 PbF HAS GATE CHARGE OF 150 - 200 nC.
TYP MAX

GATE DISSIPATION SHOULD BE

$$P = V_g \cdot Q_g \cdot f = 5 \times 200 \times 10^{-9} \times 31.5 \times 10^3$$

$$= 10^3 \times 10^{-9} \times 31.5 \times 10^3 = 31\ mW$$

= 6 mA CURRENT EQUIVALENT

GATE IS SHOWING RISETIME OF 320 nS.

$$Q = I \cdot t \qquad 200 \times 10^{-9} = I \cdot 320 \cdot 10^{-9}$$

$$I = \frac{20}{32} = \frac{5}{8} = 0.625\ A$$

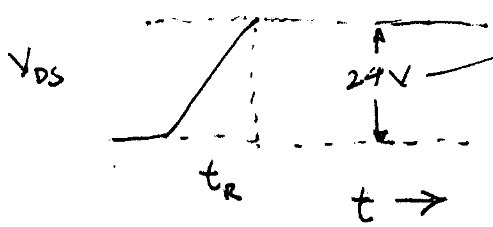
CAN DO 10x - 20x BETTER WITH DEDICATED DRIVER LIKE MIC4452

SUPPOSE I WANT A BYPASS CAP FOR DRIVER SO THAT SAG IN VOLTAGE IS 0.1V OR LESS.

$$Q = CV \qquad 200 \times 10^{-9} = C \cdot 0.1 \qquad C = 2 \times 10^{-6} = 2\ \mu F$$

CAN GET 1206 CERAMIC IN 22μF, 16V

SWITCHING LOSS AT DRAIN.



AS RUNNING NOW, IN REAL ~~SYS~~ SYSTEM, 48V.

IF DISCONTINUOUS, PEAK I_0 = 40A

POWER = VI = 24 · 40 → BUT HALF DUE TO TRIANGLE
= 480 W

$$\cdot \frac{t_R}{PERIOD} = \frac{260\ nS}{32\ \mu S} \quad \text{SAY} \quad \frac{320\ nS}{32\ \mu S}$$

$$= \frac{320 \times 10^{-9}}{32 \times 10^{-6}} = 10 \times 10^{-3} = .01$$

= 4.8 W — COULD BE 4x THIS @ 48V

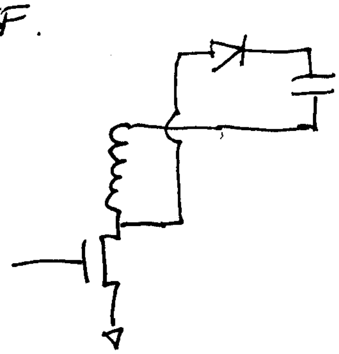
21OCT13

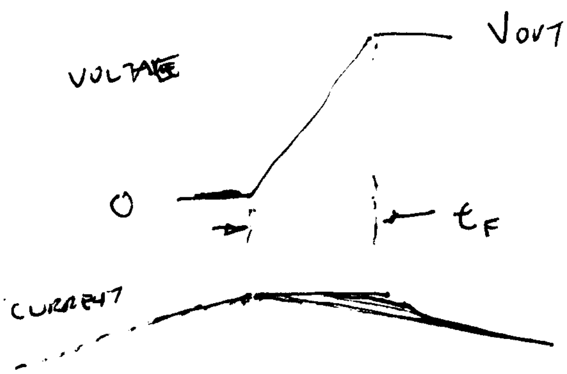
Roderick

CAN'T DO SIGNIFICANTLY BETTER WITH IRFB4110 - INHERENT RISETIME ON SPEC SHEET IS 88nS (OFF TRANSITION FALL TIME)

PROBABLY WANT SMALLER TRANSISTOR.
CAN INCREASE DRIVE, I DON'T CARE ABOUT EMI.
COULD REDUCE FREQUENCY. HAVE SPACE FOR BIGGER INDUCTOR, BUT HARD TO DOUBLE OR TRIPLE CAPACITORS.

DISCONTINUOUS SWITCHER, ASSUME CURRENT IN INDUCTOR IS CONSTANT AND AT PEAK VALUE DURING MOSFET TURN OFF.





POWER DURING TRANSITION = $\frac{V_O \cdot I_P}{2}$

CONTINUOUS AVERAGE POWER = $\frac{V_O I_P}{2} \cdot \frac{t_F}{P}$ P = PERIOD

$= \frac{48 \cdot 40}{2} \cdot \frac{t_F}{32 \times 10^{-6}} = 3 \cdot 10 \times 10^{6} \cdot t_F$

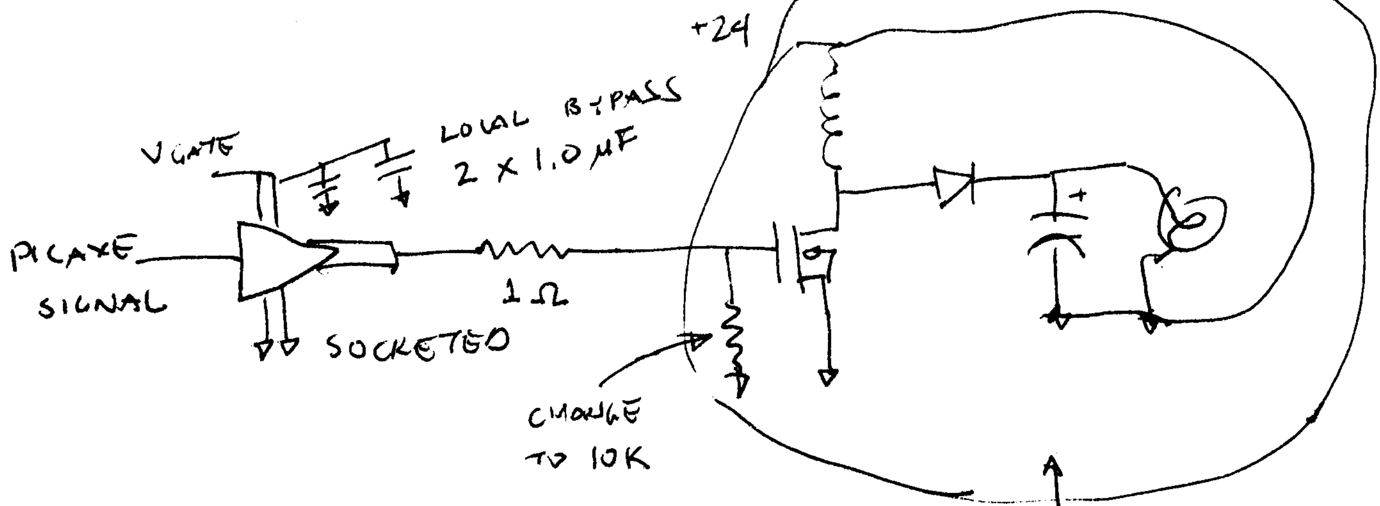
$= 3 \cdot 10^{7}\, t_F$, t_F IN SECONDS

$= .03\, t_F$, t_F IN nS.

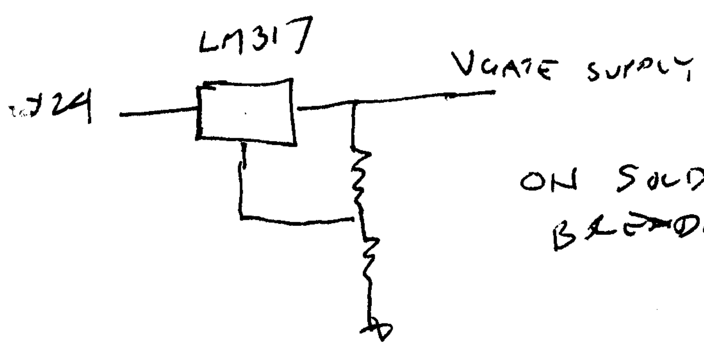
15 DEC 2013
Roderick.

BREADBOARD w/ MOS DRIVER

USE 4452 OR SIMILAR



ALREADY BUILT
BUT REBUILD
WITH DIODE
ORIENTED AS
SHOWN



ON SOLDERLESS BREADBOARD

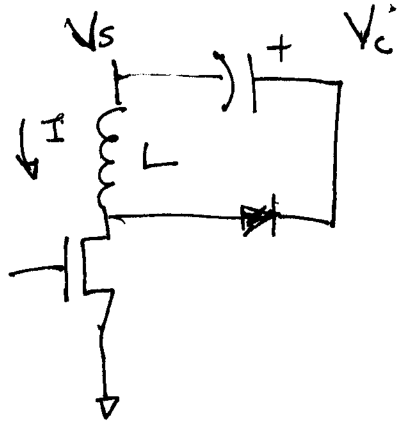
WRITE PROGRAM FOR PICAXE

- ~~PUSH BUTTON~~ WAIT FOR BUTTON DOWN
- ONE PULSE
- DELAY FOR DEBOUNCE.
- WAIT FOR BUTTON UP
- DELAY FOR DEBOUNCE

LATER, PROGRAM TO TURN ON FOR ONE SECOND ONLY

03FEB2014
Roderick.

BREADBOARD



SUPPOSE $L = 10\,\mu H$, PULSE WIDTH = $1\,\mu S$

$$E = \frac{1}{2}\, 24^2 \frac{(10^{-6})^2}{10^{-5}}$$

$$= 288 \cdot 10^{-7}$$

$$= \frac{1}{2} C V^2 = \frac{1}{2} \cdot 1000 \cdot 10^{-6} \cdot V^2$$

$$24^2 \cdot 10^{-7} = 10^{-3} \cdot V^2$$

$$24^2 \cdot 10^{-10} = V^2$$

$$24 \cdot 10^{-5} = V$$

LET L = INDUCTANCE

T = PULSE WIDTH

E = ENERGY STORED

V_s = SUPPLY VOLTAGE

V_c = CAPACITOR VOLTAGE

$$I = \frac{V_s}{L} T$$

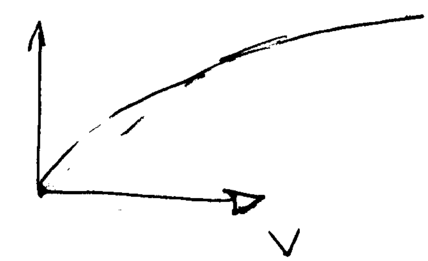
$$E = \frac{1}{2} L I^2 = \frac{1}{2} L \left(\frac{V_s}{L} T\right)^2 = \frac{1}{2} \frac{V_s^2 T^2}{L}$$

$$\frac{1}{2} C V_c^2 = \frac{1}{2} C V_{co}^2 + \frac{1}{2} \frac{V_s^2 T^2}{L}$$

$$V_c^2 = V_{co}^2 + \frac{V_s^2 T^2}{LC}$$

$$+ \frac{2 V_{co} V_s T}{\sqrt{LC}} -$$

$$\left(V_{co} + \frac{2 V_s T}{\sqrt{LC}}\right)^2 - 2$$



$$y = \sqrt{x}$$

$$\frac{dy}{dx} = \frac{1}{2\sqrt{x}}$$

→ VOLTAGE JUMP PER JOULE IS NOT THAT BIG AT HIGH VOLTAGES.

Ø3 FEB 2Ø14

SUPPOSE $L = 10\mu H$

$T = 10\mu s$

$V = 24V$

$$I = \frac{VT}{L} = \frac{24 \cdot 10^{-5}}{10^{-5}} = 24$$

$$E = \frac{1}{2} L I^2 = \frac{1}{2} \cdot 10^{-5} \cdot 24^2$$

$$\frac{1}{2} \cdot 10^{-5} \cdot 24^2 = \frac{1}{2} C V^2$$ ← ASSUMING CAP IS INITIALLY DISCHARGED

LET $C = 1000\mu F = 10^{-3} F$

$$\frac{1}{2} 10^{-5} \cdot 24^2 = \frac{1}{2} 10^{-3} V^2$$

$$~~10^3~~ \cdot 24^2 = V^2$$

10^{-2}

$$2.4 = V$$

~~AV = 0.4V~~: $\frac{1}{2} C V^2 = E = \frac{1}{2} \times 10^{-3} \times .4^2$

$$I = \frac{1}{2} L I^2 = \frac{1}{2} \times 10^{-5} \cdot I^2 = \frac{1}{2} \times 10^{-3} \times .4^2$$

$$I^2 = 10^2 \times .4^2$$

~~EFFICIENCY~~ = $\frac{1}{2} \times 10^{-5} \cdot 9^2 = \frac{1}{2} \times 10^{-5} \cdot .4^2$

$$I^2 = (10 \times .4)^2$$

$$I = 4A$$

$e =$

$$I = \frac{V}{L} t$$

$$= \frac{24}{10 \times 10^{-6}}$$

$= 2.4 A / \mu s$

$t = 3.75 \mu s$ (THEORETICAL)

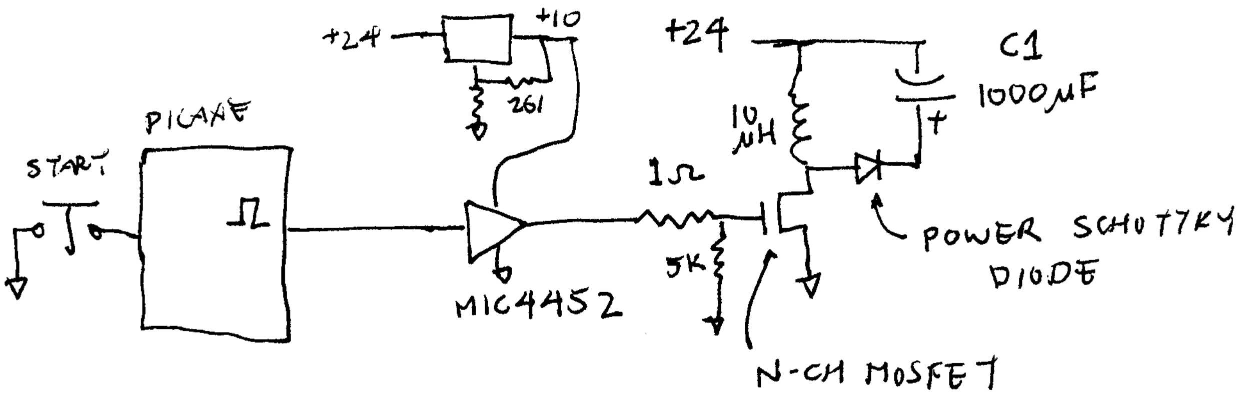
$$\text{eff} = \frac{4^2}{9^2} = \frac{16}{81}$$

3.75
2.4
———
1.5
~~1~~.7.5

$= 9.0A$

Ø4FEB14
Roderick.

BREADBOARD EXPERIMENT. WIRING IS SHORT FOR HIGH CURRENT PATHS, BUT NOT ALWAYS THICK.



WHEN (DEBOUNCED) START BUTTON IS PUSHED, ONE PULSE COMES OUT.

C1 IS INITIALLY ~~Ø~~ 0.00 VOLTS. AFTER A SINGLE BUTTON PUSH, C1 IS AT 0.43 V. CAPACITANCE IS PROBABLY MUCH MORE THAN 1000 μF ON LABEL, BUT ASSUME IT'S 1000 μF = 10^{-3} F

ENERGY OUT = $\frac{1}{2}CV^2 = \frac{1}{2} \cdot 10^{-3} \cdot (.43)^2$

ENERGY IN,

PICAXE RUNNING @ 32 MHz, PULSOUT w/ COUNT = 3 ⟹ 3.75 μS

$dI = \frac{V}{L}dt \qquad I = \frac{24}{10^{-5}H} \cdot 3.75 \cdot 10^{-6} S = 2.4 \cdot 3.75$

$= 1.2 \cdot 7.5$

$= 0.6 \cdot 15$

$= 9A$

$E = \frac{1}{2}LI^2 = \frac{1}{2} \cdot 10^{-5} \cdot 9^2$

$$\text{EFFICIENCY} = \frac{\frac{1}{2}10^{-3}(.43)^2}{\frac{1}{2}10^{-5}(9)^2} \approx \left(\frac{4.3}{9}\right)^2 = 22\%$$

BUT IF CAP IS REALLY MORE THAN 1000μF, THE EFFICIENCY IS HIGHER.

EXPERIMENT SHOWS CAP IS REALLY ~~3600 μF~~ 1048 μF

~~MEANS 879.2% EFFICIENCY!~~ 2%

WORDPRESS – [code] [/code]

→ USE <pre> </pre>