Bike Tracker

- GPS
- Connection to upload data
  - ↳ 3G (GSM), LTE, WiFi, Satellite, others?
- Connection to PC
  - ↳ USB?
  - ↳ Bluetooth, Zigbee, wireless std
- Charging
  - ↳ wall, solar, wind?
- Google Maps API
- SD storage

* hobby project, NOT for biz
  - ↳ build it, see what happens

- Idea
  - ↳ hard to track bike routes accurately
  - ↳ MapMyRide, phone, others not as effective
  - ↳ could use for mass transit, walking, other routes
  - ↳ turn on, tracks your route via GPS, uploads data to net when in range (live tracking), saves to storage when not in range for later upload

- Idea (con.)
  - ↳ easy to carry, long batt life, cheap
  - ↳ subscription to cell service?

- What method to upload?

① GSM (3G)
- established, dev kits available
- cheaper
- more coverage than 4G, but not satellite
- slower?

② LTE (4G)
- faster, newer technology
- less coverage
- more expensive
- less availability (modems avail, no easy interface) → Ask Sparkfun if modules exist

③ WiFi
- fast, cheap
- very little coverage
* good alt. (like cell phones)

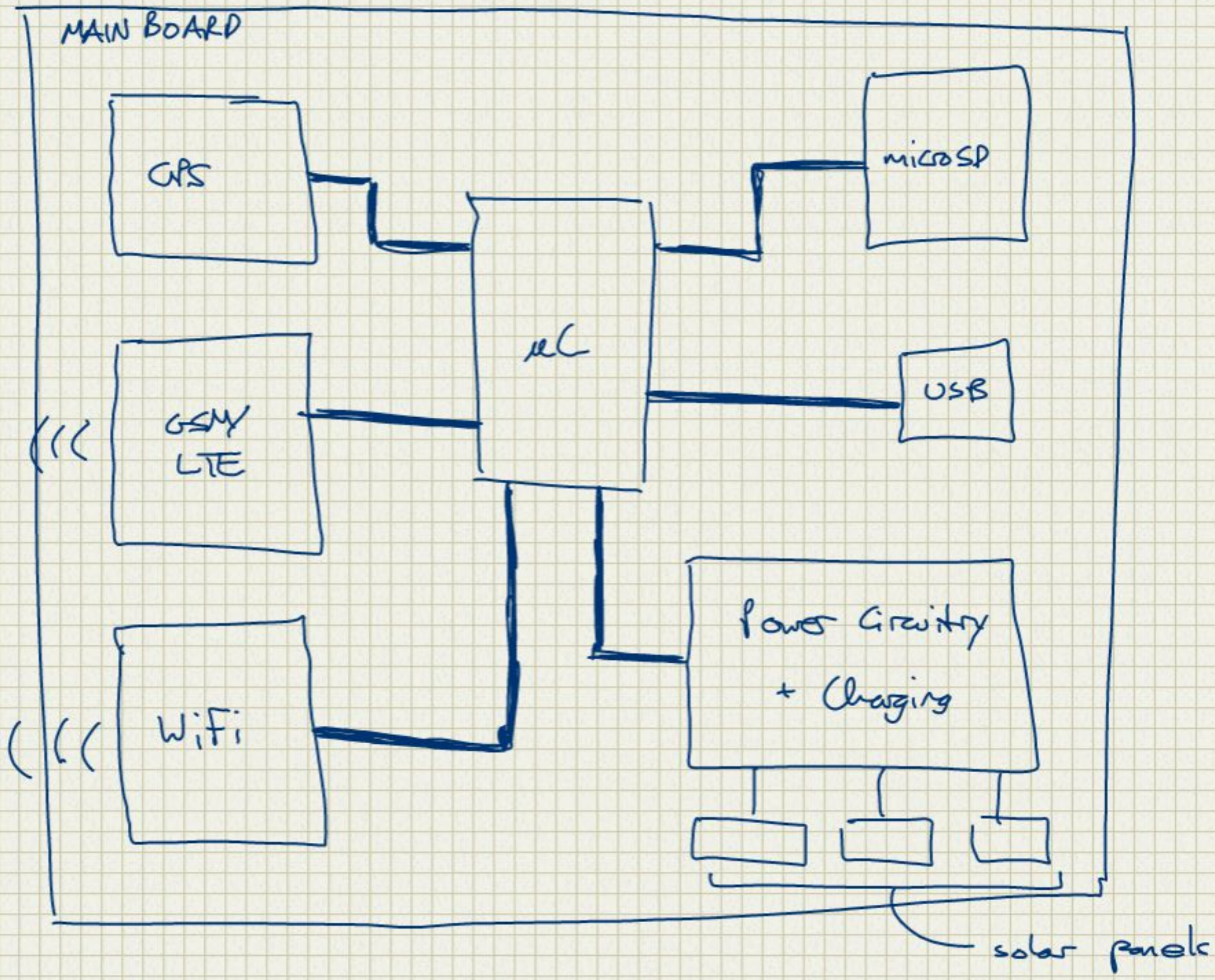
④ Satellite
- VERY expensive, need subscription (SPOT)

④ Satellite (con.)

- best coverage by far
- could do const. live tracking

⑤ WiMAX

- needs to research


MAIN BOARD
GPS
microSD
µC
USB
GSM/LTE
WiFi
Power Circuitry + Charging
solar panels

GSM/GPS Selection

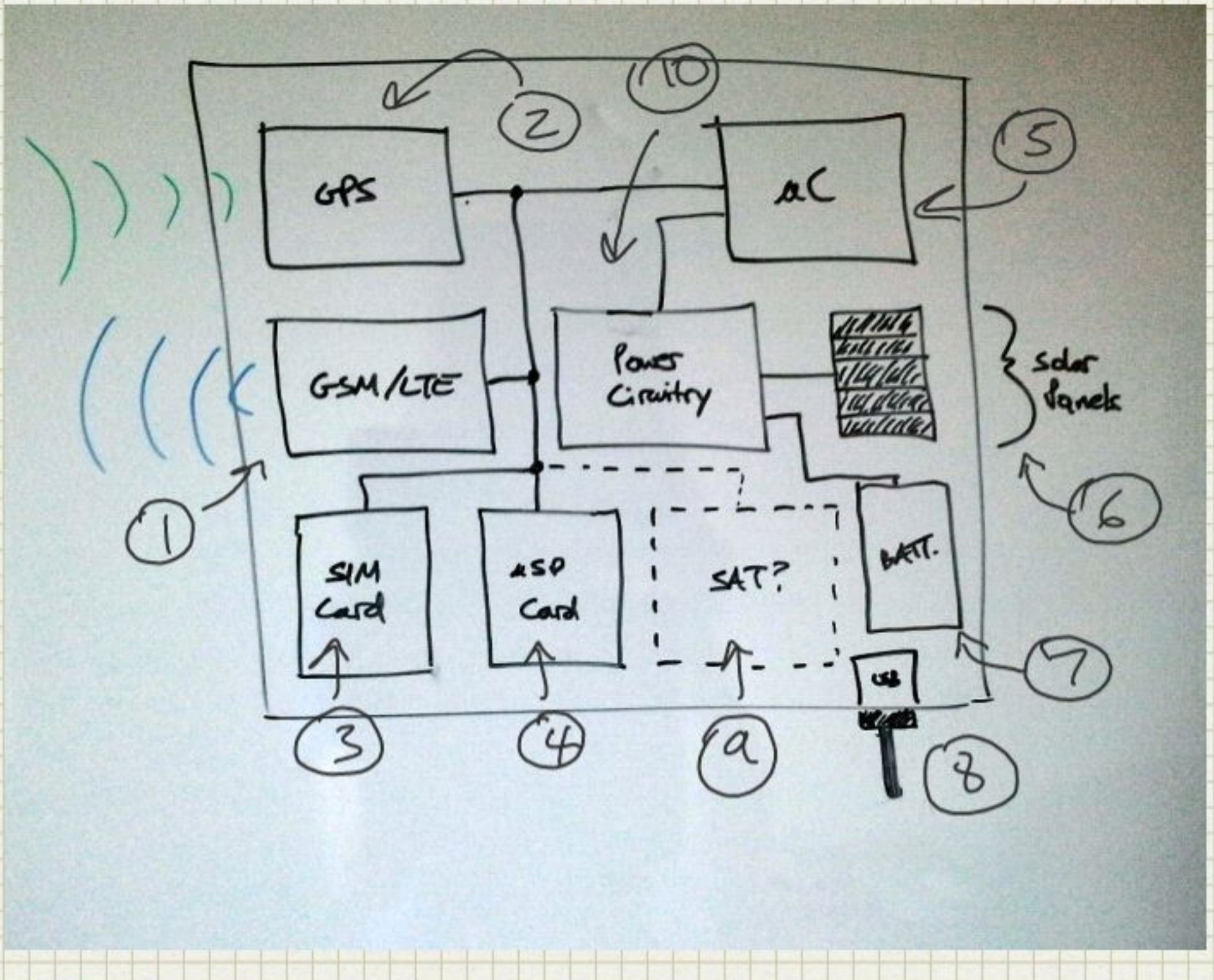
* See Google Doc
  - ↳ power vs. function vs. cost

Project Name

① "Beagle", tracking app
- ↳ "BGL" (Bike GPS Locator)
  - → issues w/ domain names ("BEAGL" more free)

9/8/2012

* Updated diagram, see next pg



Parts Needed:

1. GSM module + Antenna
2. GPS module + Antenna
3. SIM Card Holder
4. uSD Card Holder
5. uC
6. Energy Harvesting
7. Battery
8. USB
9. SAT Uplink (optional)
10. Power Circuitry

USB

* PICKit 3 comes w/ prog intf (6-pin)
  ↳ no need for USB for programmer

- used to get data fr. uC → PC
  ↳ can be used for debug + final version for downloading data

* need USB to serial intf.
  ↳ both SFE, Adafruit have board w/ FT232RL
    → SFE board mainly for Arduino
    → Ada lets you pick RTS vs. DTS (reg. cable vs. Arduino) → use theirs
    ⊛ needs 4-5.25V w/o ext osc!

⊛ Breakout, access to more sigs

SD Card

* use microSD to save space, lower pwr?
  ↳ Ada has best one, breakout + shifting, LEDs
  ↳ SD card: Amazon 8GB Class 10 card ordered

uC

- Interfaces: USB: 1.8-5.25V 10s, need 4 (min) sigs to uC (spec, p. 30): UART (TXD/RXD)

  uSD: 3.3-5V, need 4 sigs to uC: SPI (use HW pins)

  GSM: * need 3.7V Li-Ion battery for charging! *

batt charge?

↓

GSM: (con) 6 sigs for GPIOs, 6 sigs for UART0, 2 sigs for UART1, 3 AUX sigs; 5 sigs for SPI LCD (or GPIO), 10 sigs for keypad (or GPIO); 3.3 - 4.2V

GPS: 3.0 - 4.3V, need 5 sigs for UART

uC Characteristics

- Voltage: 3.3 - 4.2V
- IOs: 45
  - ↳ 4x UART
  - ↳ 2x SPI (1 for LCD)
- 16-bit or 32-bit arch (see below?)
- Needs processing power for GPS

September 12, 2012

uC Choices

- TI (430)
- Microchip
  - ↳ check out low pwr (XLP) versions

(Q) What arch? (8/16/32b)

- ↳ AN1373, uses PIC32 MCU to dev. GPS, GSM (PIC32MX..)
- ↳ in conjunction w/ M2M daughterboard, also 32
  - → use uBlox parts! ($200)
- ↳ some forum posts using 16-bit

Candidates

① PIC24F

② ~~MSP430F5xx~~ (skip TI)

③ PIC32MX

④ PICXLP24F

Criteria

- # IOs
- Voltage Range
- Power Consumed
- Price
- Core Size/Speed
- 4 UARTs, 2 SPI intf's
- RAM Size
- Prog Memory Size
- Pkg

* See MCU Selection in Google Docs
  - → NOTE: PIC32 doesn't support > 2 UARTs!
  - → MSP430F5xx also doesn't support > 2 (some 3)
  - → dsPICs also don't support > 2 (+24H)

UART issues

- 2 needed for sure (GSM, GPS)
- 1 for USB → UART intf
  - ↳ bit bang? have integ'd USB
- 1 for 2nd intf on GSM → mainly for debug, simple intf → can get away w/ (2/3)

↓

Other Notes

- RAM size not a concern, copy data off to SD card (time hit?)
- (*) Check prog mem size when compile code
  - ↳ CONCLUSION: for now, go w/ reg PIC24F series!

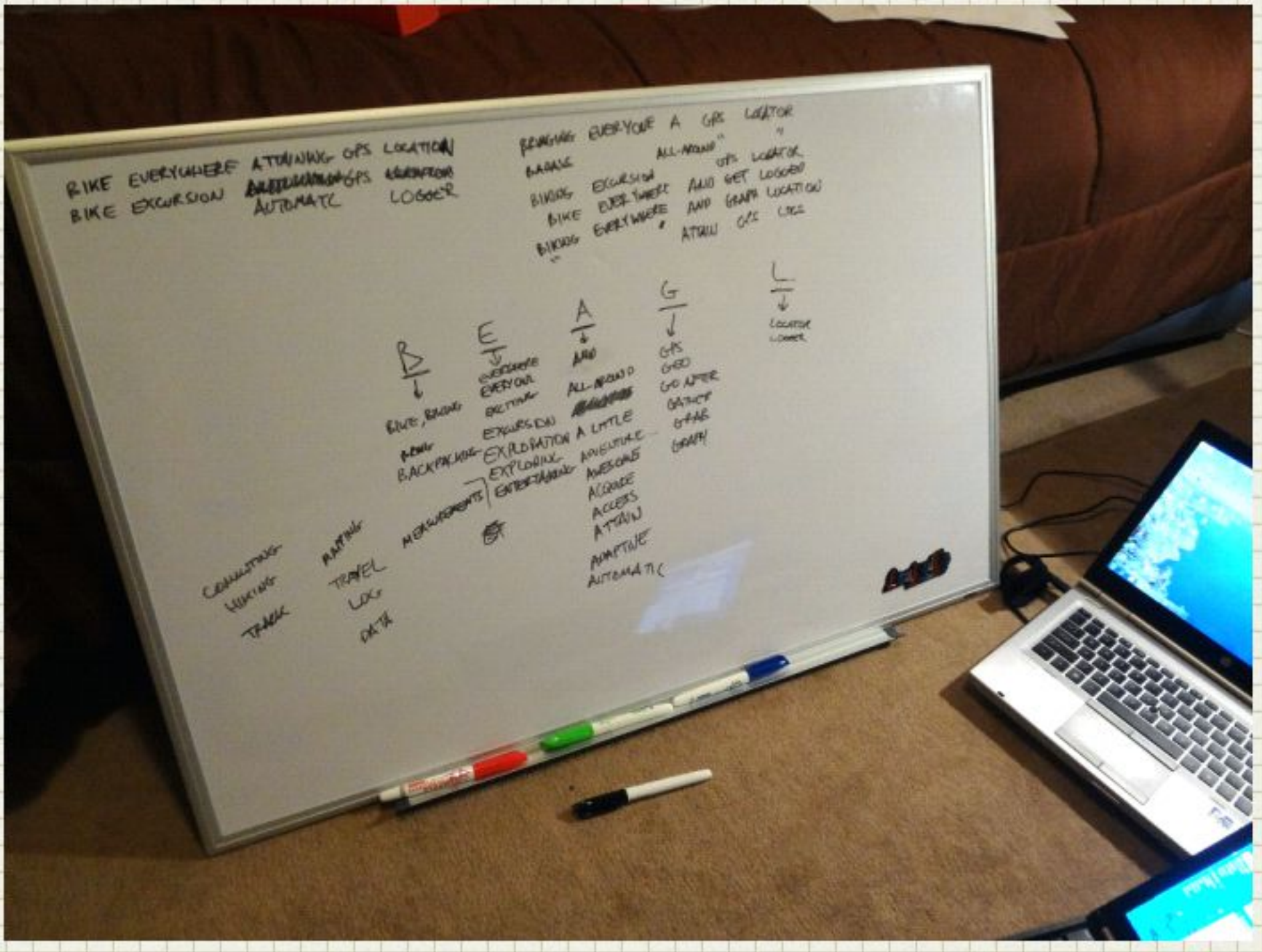
Converter Board: 64-TQFP → DIP (PA0096)

September 14, 2012

Name

Bike Excursion Automatic GPS Logger

↳ after lots of brainstorming:



Next up

① Battery

② Charging - solar, etc?

③ Power Control/Supply

- once all main components selected, read specs for pwr, discrete req's
  - ⊛ fully understand, wire; test ea sys one at a time for running all.

September 16, 2012

Discrete Parts

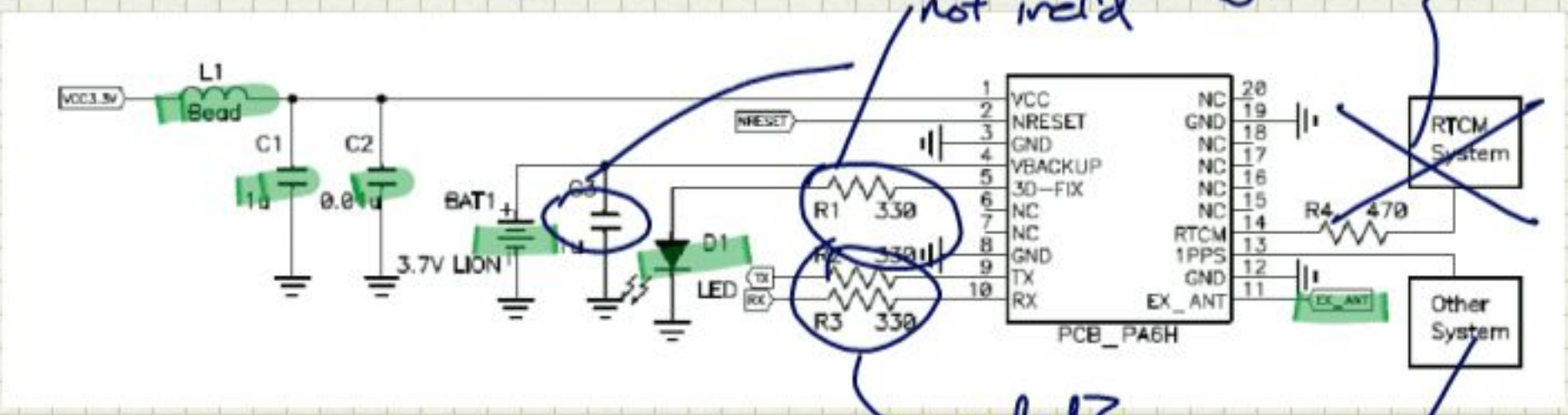
- ea dev req's add'l parts

① GPS

↳ Reference design, spec p. 26

↳ w/ breakout board, don't need everything

not incl'd by default



↳ Parts: 2x 330R R's, 1x 1uF Cap, LED

② GSM

↳ Reference design, spec (HW and datasheet)

→ keypad not cnn'd, SIM all wired

→ mic avail. not using

→ RTC batt not hooked up; neither is VCHG

* looking at components needed now (not w/ real version)

→ no VBAT, NETLIGHT (GPIO26)

→ fancier SM circuit, not using w/ breakout

(3) uSD

↳ good to go (see tutorial site)

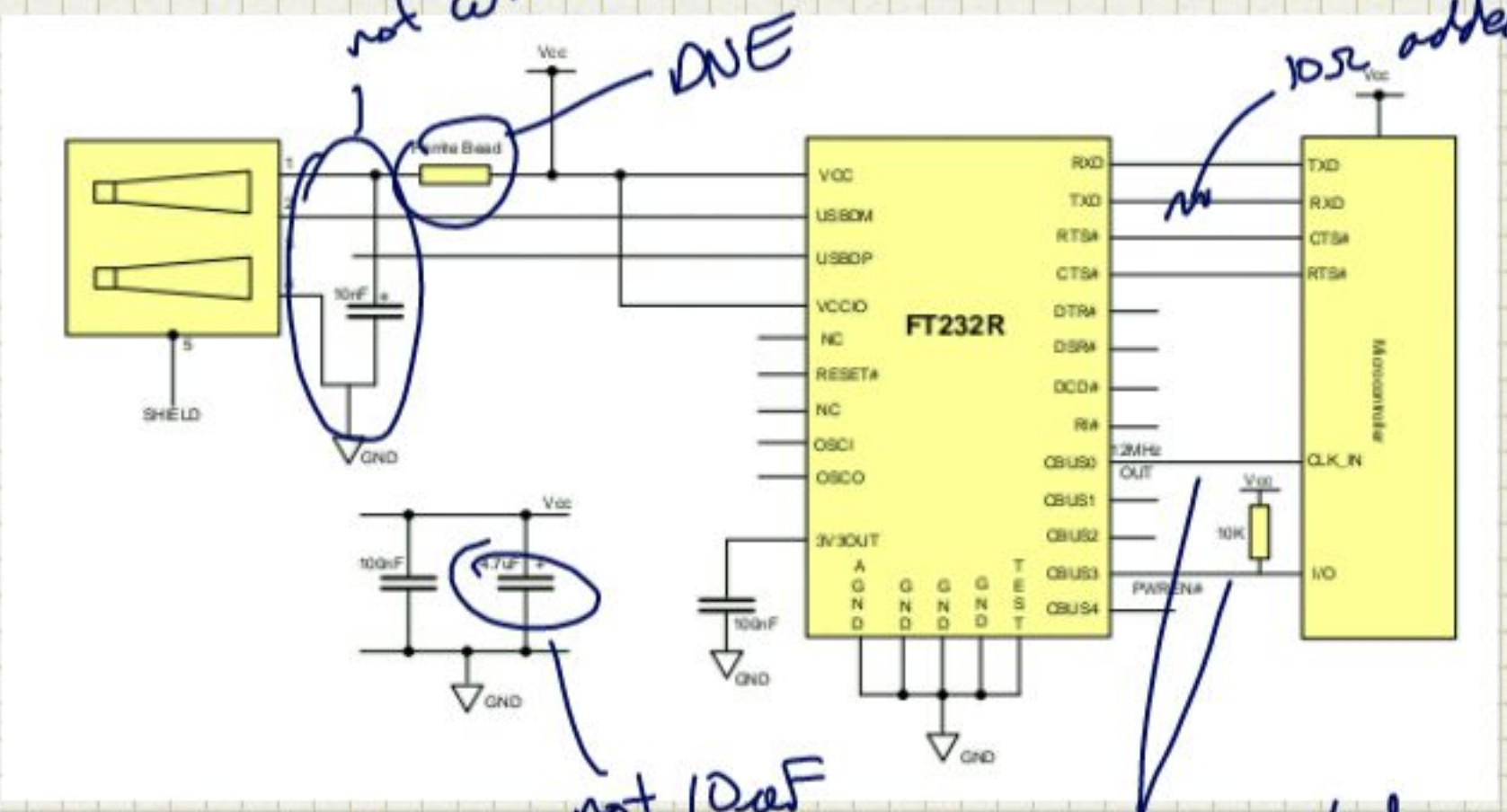
↳ use sch for final proj

(4) USB

↳ using it as UART (Spec, p. 30 for uC conn's)

↳ no special CBUS func's other than TX/RX lights

not connd



(3) uC

↳ see diag, p. 31

↳ need: 6x 0.1uF, 20V ceramic, 10uF 63V ceramic, 10k, 100-470R

* section 2

↳ $\overline{MCLR}$: 1x 10k (or less), 1x 470Ω (or less), jumper (for prog modes

↳ ENVREG: will be using pin (3.3 → 1.8V)

→ needs a 10uF 6.3V ceramic

Parts List

2x 330Ω Resistor

1x 1uF Capacitor

1x LED

6x 0.1uF, 20V ceramic capacitor

1x 10uF, 6.3V ceramic capacitor

1x 10kΩ Resistor

1x 100-470Ω Resistor

1x jumper → use wire on breadboard

1x 10uF, 6.3V Ceramic Capacitor

= should have in SEA

Final Order

① uC

② converter board

* Next up: power!

September 25, 2012

Solder Paste

- See instructable on Porkbot
  - ↳ solder paste : Stencils Unlimited, Pb-free no clean → cred card to apply
  - ↳ stencils : Pololu w/ Eagle gerbers
  - ↳ hotplate : std fr. store
    - → might want temp ctl'd or dev own sys
  - * Article : extreme SMT soldering
- for TQFP, need to rev header pins or bot first OR order new board
- use TQFP for Microchip uC, need to use Ultra Librarian (win tool) to gen for Eagle
  - ↳ PIC24FJ256GB206-I/PT
- use book to do Gerber output in Eagle, verify by viewing online (Cirwit People)
- * ADX portland, tutorial on making board there
- * make a generic stencil based on SMT parts, order:

① TQFP - 32, 44, 64, 100 — see specs

② SOIC - 8, 8W, 14, 16, 18, 28

③ SSOP 24, 28

④ TSSOP 16, 20, 28

⑤ MLF 32

⑥ QFN 20, 24, 28, 32, 36, 64

µC: TQFP-64 ✓ (Microchip lib)

USB: SSOP-28 ✓ (SF lib)

GPS: custom ✓ (Adafruit lib)

GSM: custom 60-pin conn ✓ (SF lib)

September 27, 2012

Power Distribution

GSM: 3.3-4.2V @ 2A MAX (3.6V typ)

↳ must guarantee 3.3V min during burst (450 mV drop)

→ cellular shield regulates to 3.8V

GPS: 3.0V-4.3V (ripple below 50 mV_{pp}) (3.3V typ)

@ 25mA

→ breakout regulates to 3.3V

µC: 2.0V-3.6V @ 200mA MAX

* do not use V_{out} of GSM as pwr input to µC, I_D = 50mA max!

USB: V_{CCIO} = 1.8V - 5.25V for intf pins (µC)

V_{CC} = 3.3V - 5.25V @ 24 mA/IO (x13)

* V_{CC} must be 4.0V when using int'l clk gen!

→ breakout switches to 3.3V or 5V

→ uses V_{CC} = 5V from USB port!

uSD: card operates at 2.7v-3.6v @ 500mA

Summary

3.6v @ 2A → (Vreg) 3.8v @ x

$3.8x = 3.6(2)$

$x = 1.89A$

(Vreg) 3.3v @ 25mA

2.0-3.6v @ 200mA (3.3v typ)

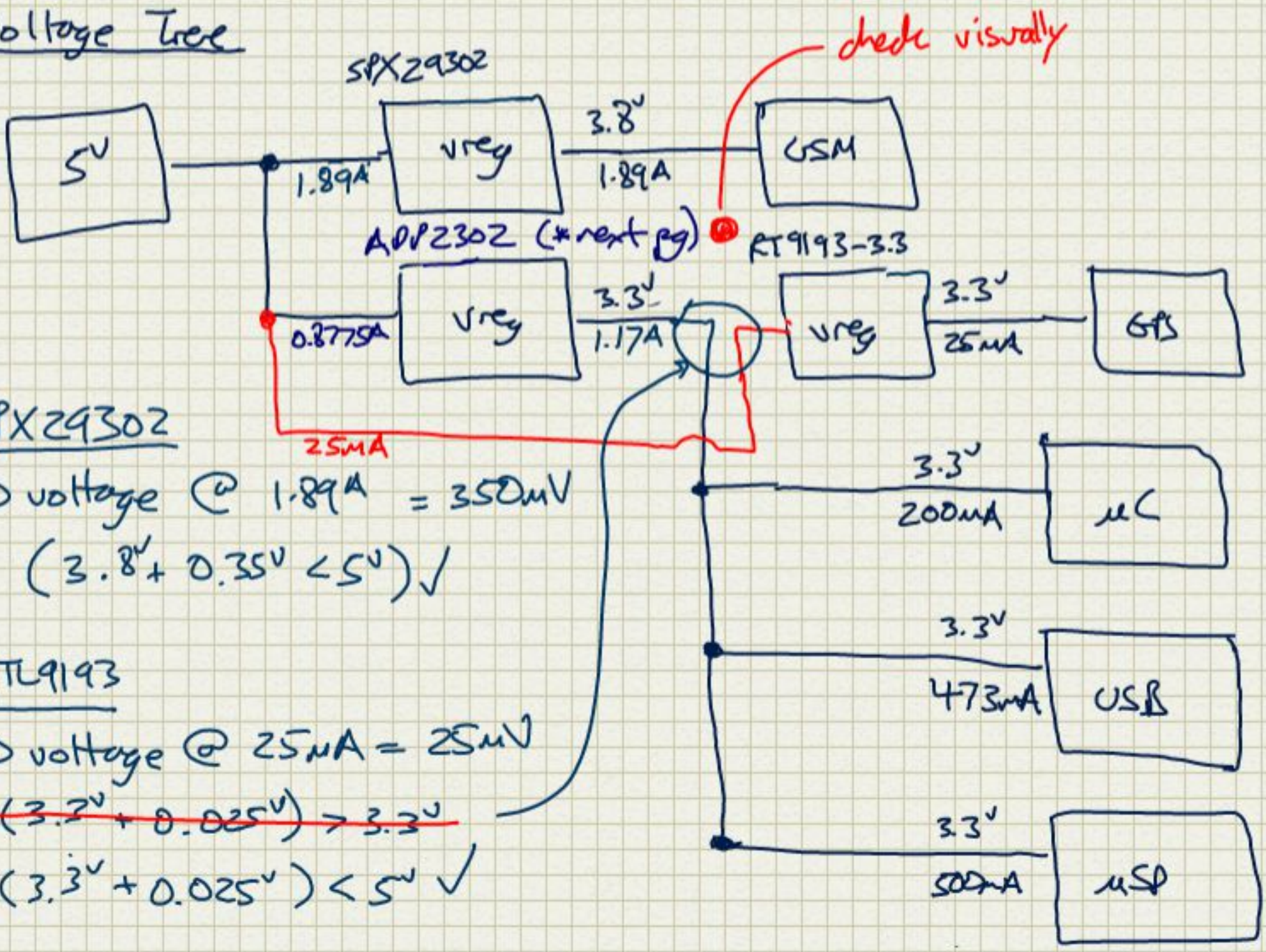
5v (312mA) = 3.3y

$y = 473mA$

5v @ 312mA → 3.3v @ 473mA

3.3v @ 500mA

Voltage Tree



SPX29302

DO voltage @ 1.89A = 350mV

$(3.8v + 0.35v < 5v)$ ✓

RTL9193

DO voltage @ 25mA = 25mV

~~$(3.3v + 0.025v) > 3.3v$~~

$(3.3v + 0.025v) < 5v$ ✓

2A 5v - 3.3v Vreg

- Linear
  - ↳ Fairchild KA278R33C — no linear (christie), not efficent
  - ↳ Maxim MAX8527 (SMT)
- Switching

	Efficency @ 1.17A	
↳ National LM2592HVT-3.3	67%	(effic.)
↳ STM A5973D	88%	(comp)
↳ Semtech SC4524K	85%	(effic)
↳ Intersil ISL8012	93%	(plug)
↳ TI TPS54218	93%	(comp)
↳ Fairchild FAN8301	88%	(comp)
↳ Rohm BP5232A33	89%	(plug)
↳ Enpirion EN5322QI (SMT)	92%	(plug)
↳ Diodes Inc. AP1509	78%	(effic)
↳ Analog APP2302	88%	
↳ Maxim MAX1951	92%	(comp)

fixed Vout, less comp's

↓

Efficiency:

$\eta = 88\%$ $\quad V_{in} = 5^V$ $\quad V_{out} = 3.3^V$

$I_{in} = ?$ $\quad I_{out} = 1.17^A$

$P_{out} = \eta P_{IN}$

$$V_{out} \cdot I_{out} = \eta V_{in} \cdot I_{in} \rightarrow I_{in} = \frac{V_{out} \cdot I_{out}}{\eta V_{in}}$$

$$I_{in} = \frac{(3.3^V)(1.17^A)}{(0.88)(5^V)} = \underline{\underline{0.8775^A}}$$

AC Adapter:

5^V, $I = 0.8775^A + 1.89^A + 0.025^A = \underline{\underline{2.7925^A}}$

Need: $5^V, 3^A$ AC Adapter

* BATTS! *

* ADP Parts Selection, see notes on spec!

October 2, 2012

ADP Design (use Design Ex in spec)

① Catch Diode
② Inductor
③ Input Cap
④ Output Cap

} spec part choices in spec!

Parameter	Specification
V_{IN}	$5^V \pm 0.075^V$ (1.5%) ← AC adapter spec, p. 1
V_{OUT}	3.3^V, 2^A, 1% ripple
Programmable UVLO	Connect to V_{IN}

① Diode

↓ use Schottky, $V_D = 0.45^V$ (specs)

$$I_{D(AVG)} = \left(1 - \frac{V_{OUT} + V_D}{V_{IN} + V_D}\right) \cdot I_{LOAD(MAX)}$$

$$= \left(1 - \frac{3.3^V + 0.45^V}{5^V - 0.45^V}\right) \cdot 2^A = \underline{\underline{352mA}}$$

Choice: ANY diode in Table 7 (p.18) would work

↳ for proto (PTH), use: **Fairchild 1N5817FSCT**

② Inductor

$$L = \frac{(V_{IN} - V_{OUT})}{0.3 \cdot I_{LOAD(MAX)} \cdot f_{SW}} \cdot \left(\frac{V_{OUT} + V_D}{V_{IN} + V_D}\right)$$

$V_D = 0.45^V$

$f_{SW} = 700kHz$

$$L = \frac{(5^V - 3.3^V)}{0.3 \cdot 2^A \cdot (700 \times 10^3 Hz)} \cdot \left(\frac{3.3^V + 0.45^V}{5^V + 0.45^V}\right)$$

$$L = (4.05 \times 10^{-6} H) \cdot (0.688) = \underline{\underline{2.79\,\mu H}}$$

Choice: ANY 2.5 - 3.5uH part in Table 8 (p.18)

↳ w/ L = 2.8uH, (!) w/ $I_{SAT} > I_{peak}$

$$\Delta I_{RIPPLE} = \frac{(V_{IN} - V_{OUT})}{L \cdot f_{SW}} \cdot \left(\frac{V_{OUT} + V_D}{V_{IN} + V_D}\right)$$

$$= \frac{5^V - 3.3^V}{2.8uH \cdot 700 \times 10^3 Hz} \cdot \left(\frac{3.3^V + 0.45^V}{5^V + 0.45^V}\right)$$

$$= \underline{597mA}$$

$$I_{peak} = I_{LOAD(MAX)} + \frac{\Delta I_{RIPPLE}}{2} = 2^A + \frac{597mA}{2}$$

$$= \underline{2.30^A}$$

↳ for proto (PTH), use: TDK TSL1112RA-3R3M5R9-PF

→ L = 3.3uH

ΔI_{RIPPLE} = 506mA

I_{peak} = 2.25A OK✓

(3) Input Cap

- needs to w/stand $I_{IN(RMS)}$ as its max I_{LOAD} and max V; X5R or X7R; 10uF use good

↓

$$I_{W(RMS)} = I_{LOAD(MAX)} \cdot \sqrt{D \cdot (1-D)}$$

$$D = \frac{V_{OUT} + V_D}{V_{IN} + V_D} = \frac{(3.3^V + 0.45^V)}{(5^V + 0.45^V)} = \underline{0.688}$$

$$I_{W(RMS)} = 2^A \cdot \sqrt{.688(1-.688)} = \underline{\underline{0.927^A}}$$

Need: 5V, 1A rated cap

↳ For proto (PTH), use: **TDK FK20X7R1C106K**

(4) Output Cap

$$\Delta V_{RIPPLE} = \Delta I_{RIPPLE} \left(\frac{1}{8 \cdot f_{SW} \cdot C_{OUT}} + ESR \right)$$

w/ L = 3.3uH:

$\Delta I_{RIPPLE} = 506mA$

$\Delta V_{RIPPLE} = 33mV$ (1% of V_{OUT})

$f_{SW} = 700kHz$

Choose ESR = 3mΩ (spec chose, same type caps)

$$0.033^V = 0.506^A \left(\frac{1}{8 \cdot 700 \times 10^3 Hz \cdot C_{OUT}} + 3 \times 10^{-3} \Omega \right)$$

$$C_{OUT} = 2.87uF$$

Based on Table 11 (p. 27), use $\underline{\underline{2 \times 22uF}}$

For Proto (PTH), use: **TDK FK22X7R1C226M**

Cost Comparison

EVAL Board = $60

Parts (vreg + L+ in/out caps + diode)

= $2.90 + $0.90 + 2·$1.57 + $0.63 + $0.50

= $8.07

$$\% \text{ difference} = \frac{\$60 - \$8.07}{\$8.07} \times 100 = \underline{\underline{644\%}}$$

(big savings ☺)

October 3, 2012

Interfacing

① Micro SD
↳ see Adafruit, generic spec

- 5V = 3.3V rail (3-5V tolerant)
- SPI I/F, use HW pins (not bit banging)

"CLK" → SCK

"DO" → MISO

"DI" → MOSI

"CS" → SS

- PIC, use following pins: (Ch 15 of Manual)
  ↳ mapped based on PPS (Section 10.4)

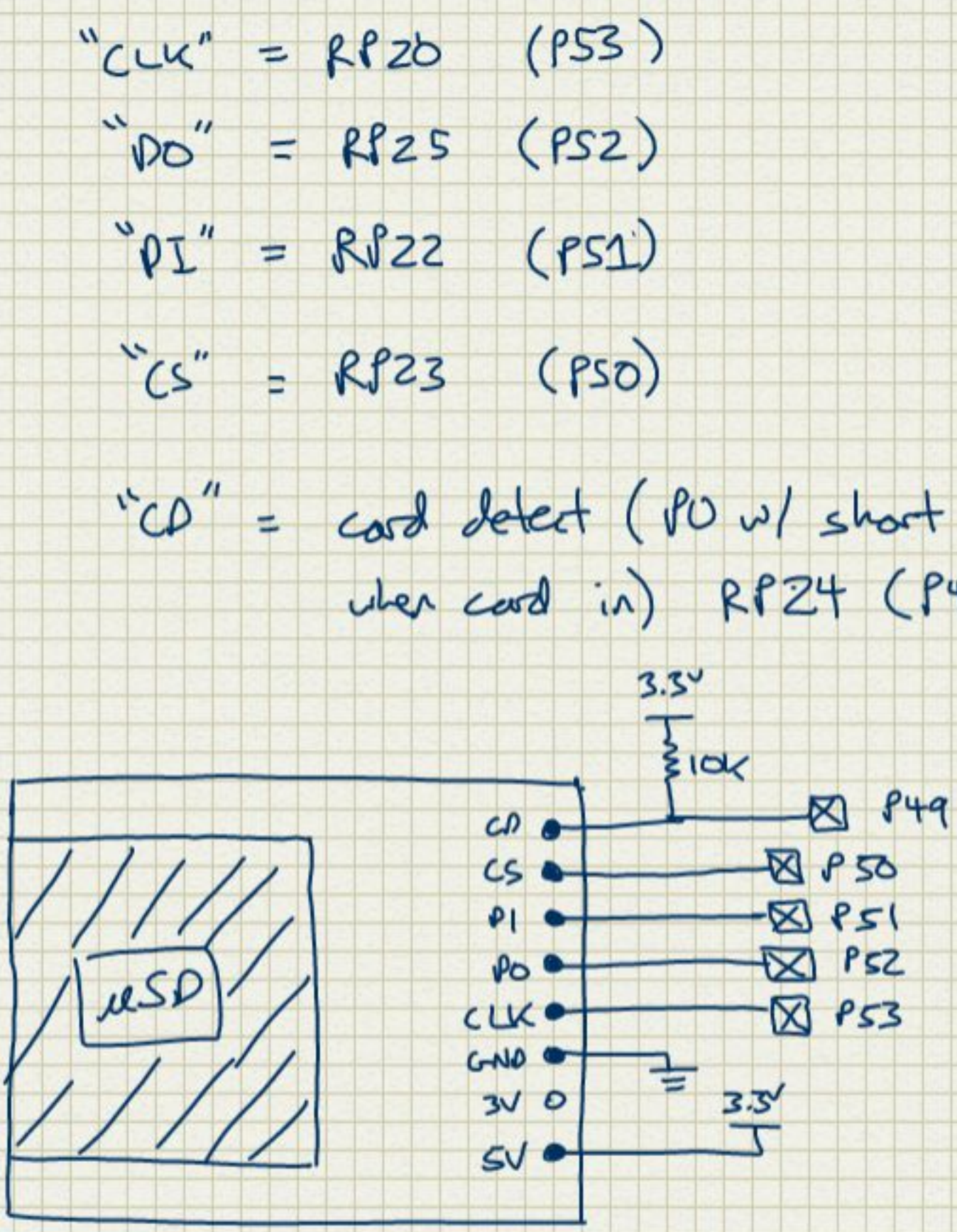
"CLK" = RP20 (P53)

"DO" = RP25 (P52)

"DI" = RP22 (P51)

"CS" = RP23 (P50)

"CD" = card detect (PU w/ short to GND when card in) RP24 (P49)



(2) USB

↳ USB to uC UART I/F (spec, p.30)

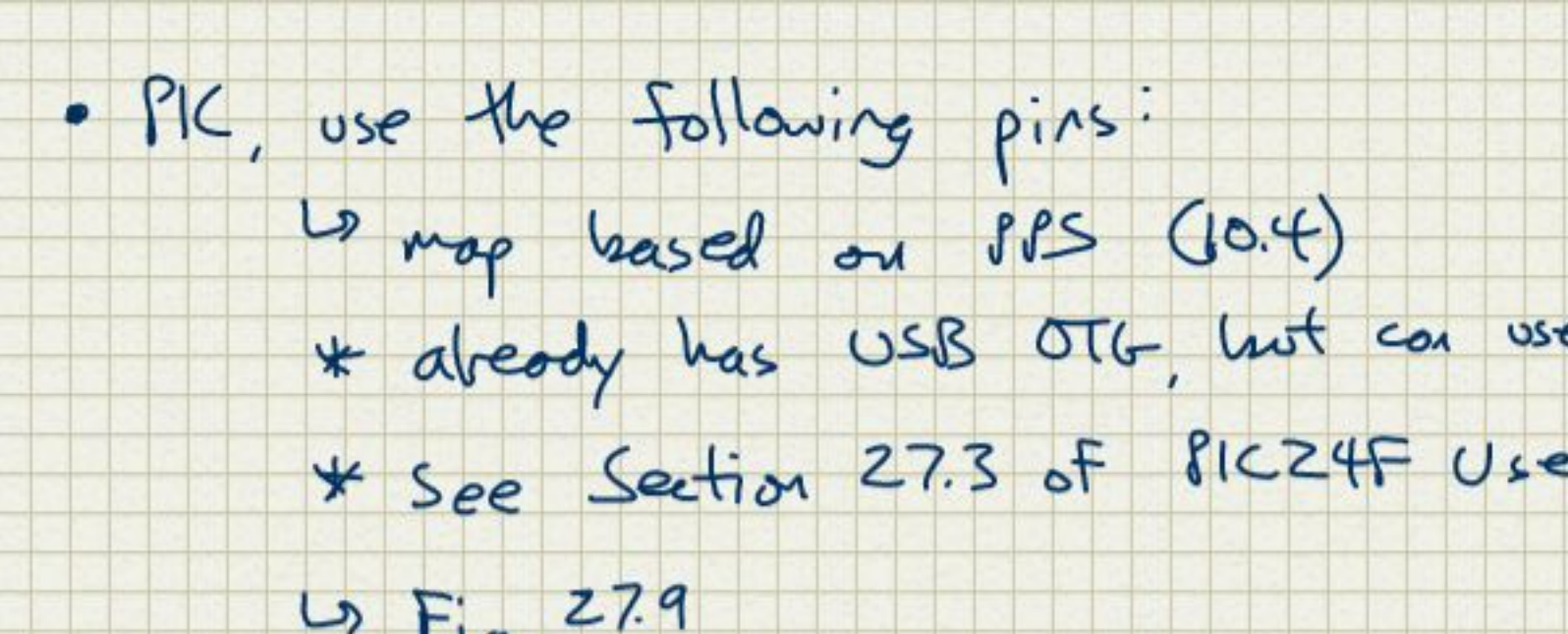
not avail for proto

- RXD → TXD
  TXD → RXD
  RTS# → CTS#
  CTS# → RTS#
- 5 CBOS pins, conn to I/Os for extra functionality
- V_{CC} = 3.3V (5V tolerant)

- PIC, use the following pins:
  - ↳ map based on PPS (10.4)
    - * already has USB OTG, but can use ext'l
    - * See Section 27.3 of PIC24F User Manual
  - ↳ Fig 27.9

→ using USB→ UART w/ UART (NOT USB)

"CTS" = RP4 (P43)
"TX" = RP3 (P44)
"RX" = RP12 (P45)
"RTS" = RP11 (P46)



→ PIC incl's CTS/RTS!

October 4, 2012

(3) GSM

- proto board lacks 2nd UART, keypad, GPIOs
- SW serial or UART (jumpers)
- RESET attached to SW or shield
- conn's to UART0 TXD/RXD

(*) non-proto, need to re-review the doc'n!

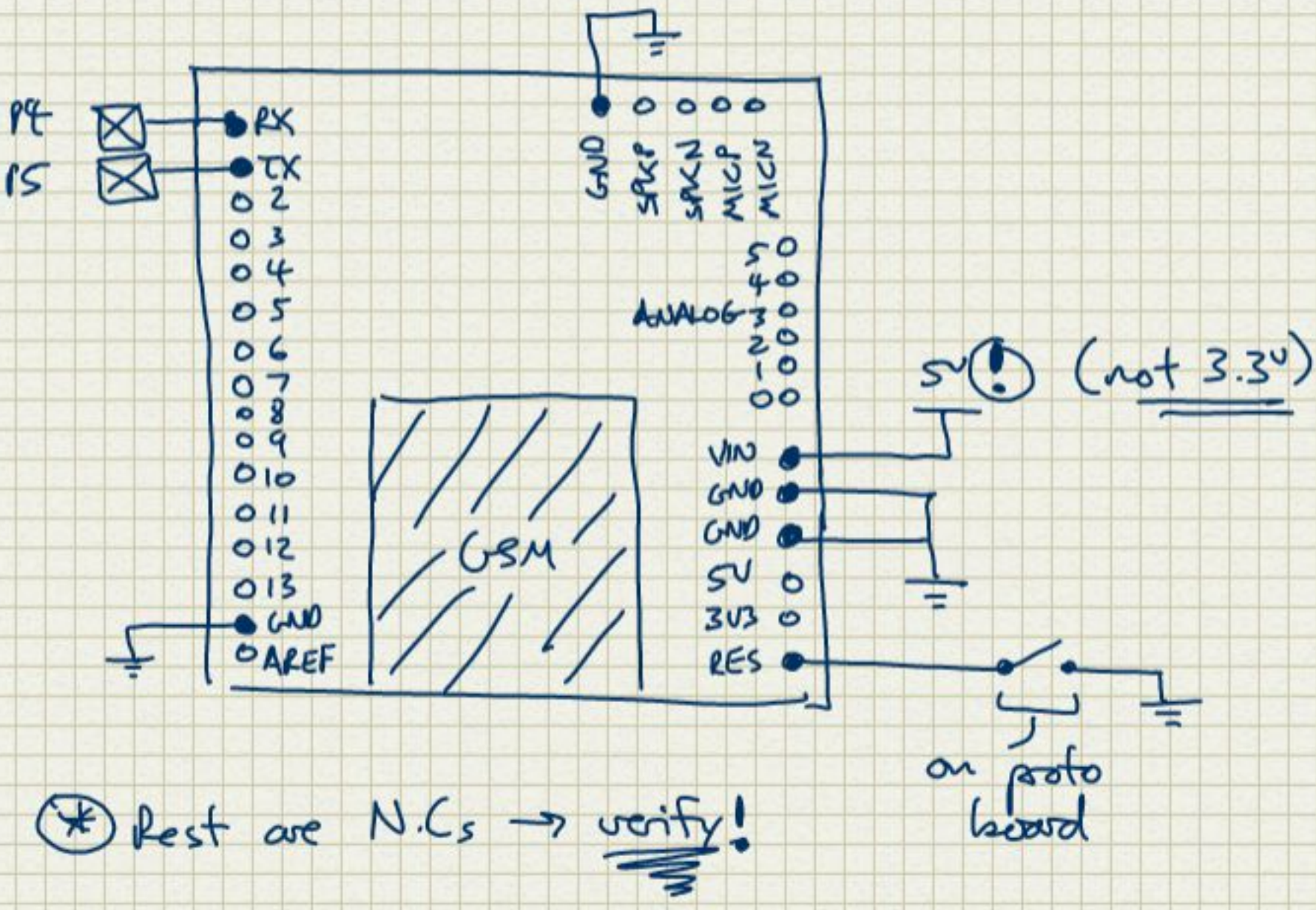
- Not using UART as 6-wire, but 3-wire (incl GND)
  - future, add more functs

→ (Q) what are other headers pins for?

- PIC, use following pins (based on PPS, IO4):

"RX" = RP21 (P4)

"TX" = RP26 (P5)



(*) Rest are N.Cs → verify!

(4) GPS

- AdaFruit tutorial, use Arduino wiring
- $V_{IN} = 3.3V$, FIX = input to uC for sig lock
- V_{BAT} not used in proto until have batt. backup

- EN pulled ↑ via 10k (already), tie to µC and pull to GND to disable GPS
- 3.3V output ONLY 100mA, don't use!
- PPS is µC sync sig
- uses UART (TX/RX) for xfer
- PIC, use following pins (PPS, 10.4)

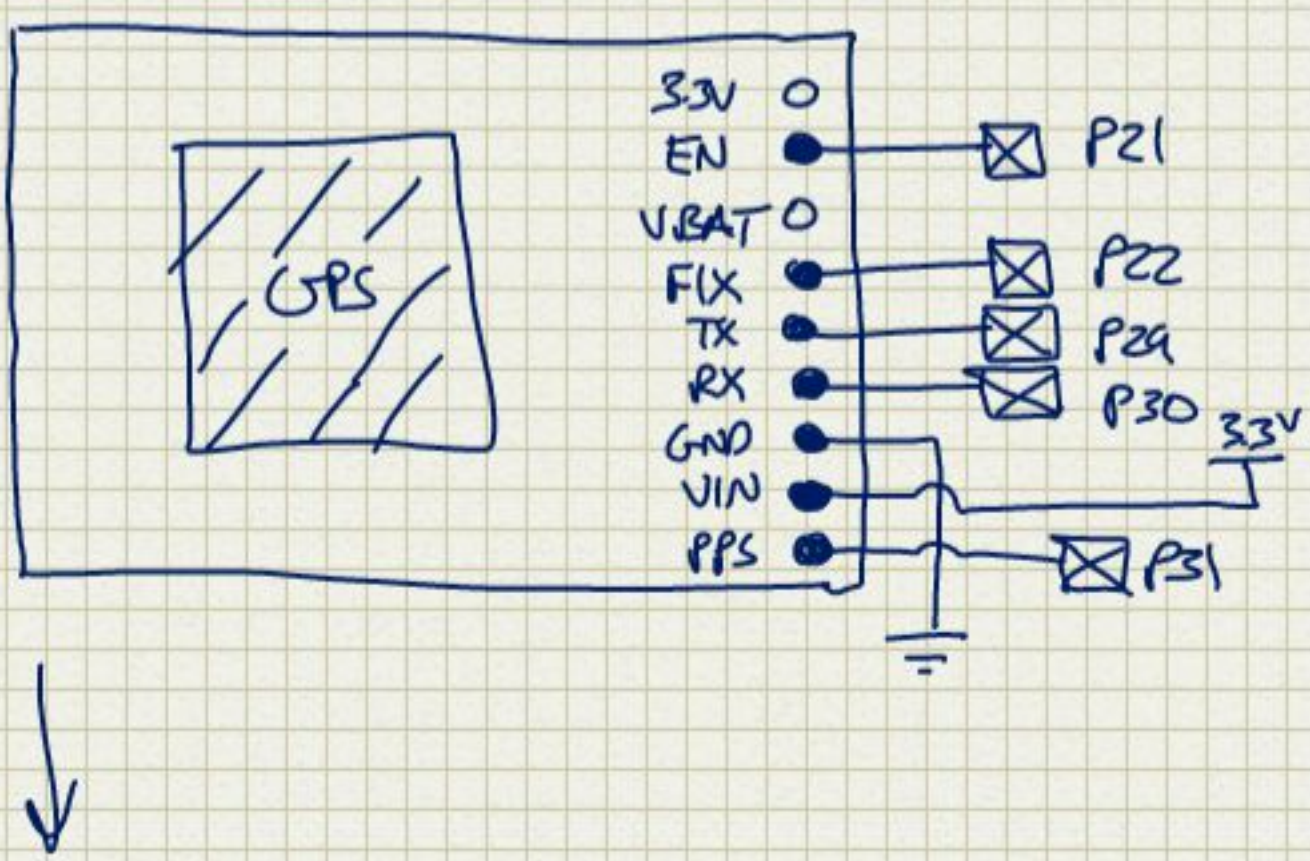
"EN" = RP8 (P21)

"FIX" = RP9 (P22)

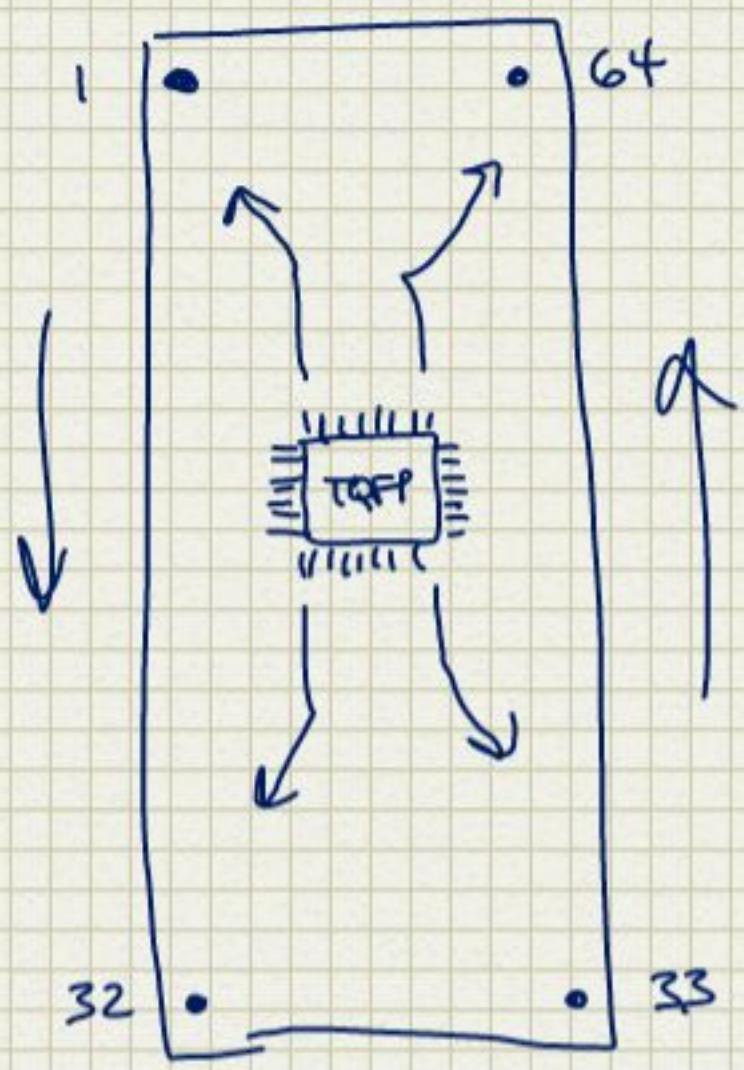
"TX" = RP14 (P29)

"RX" = RP29 (P30)

"PPS" = RP10 (P31)



Proto TQFP-64 Layout:



(TOP)

B 0
B 1
R 2
O 3
Y 4
W 5
B 6
V 7
G 8
W 9

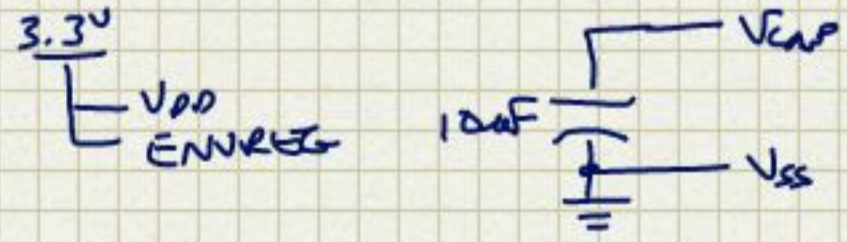
October 8, 2012

PIC Hookups

- See Fig 2.1, p. 31
  - ↳ connect all V_{DD}, V_{SS} pins (AVDD, AVSS too)
  - ↳ $\overline{MCLR}$ (Section 2.3) → jumper for <1 when prog'g
  - ↳ ENVREG, V_{CAP}

*ISP, need pins (Section 2.5)

- need int'l reg for 3.3v → 1.8v conversion (Fig 26-1)

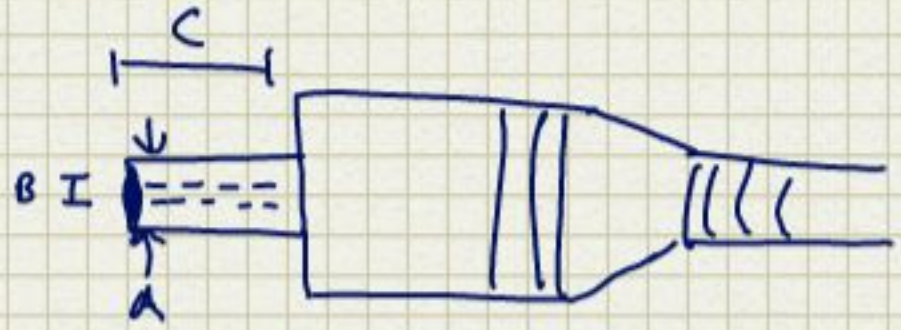


AC Adapters

October 9, 2012

... – PSP – ....

→ Center Positive



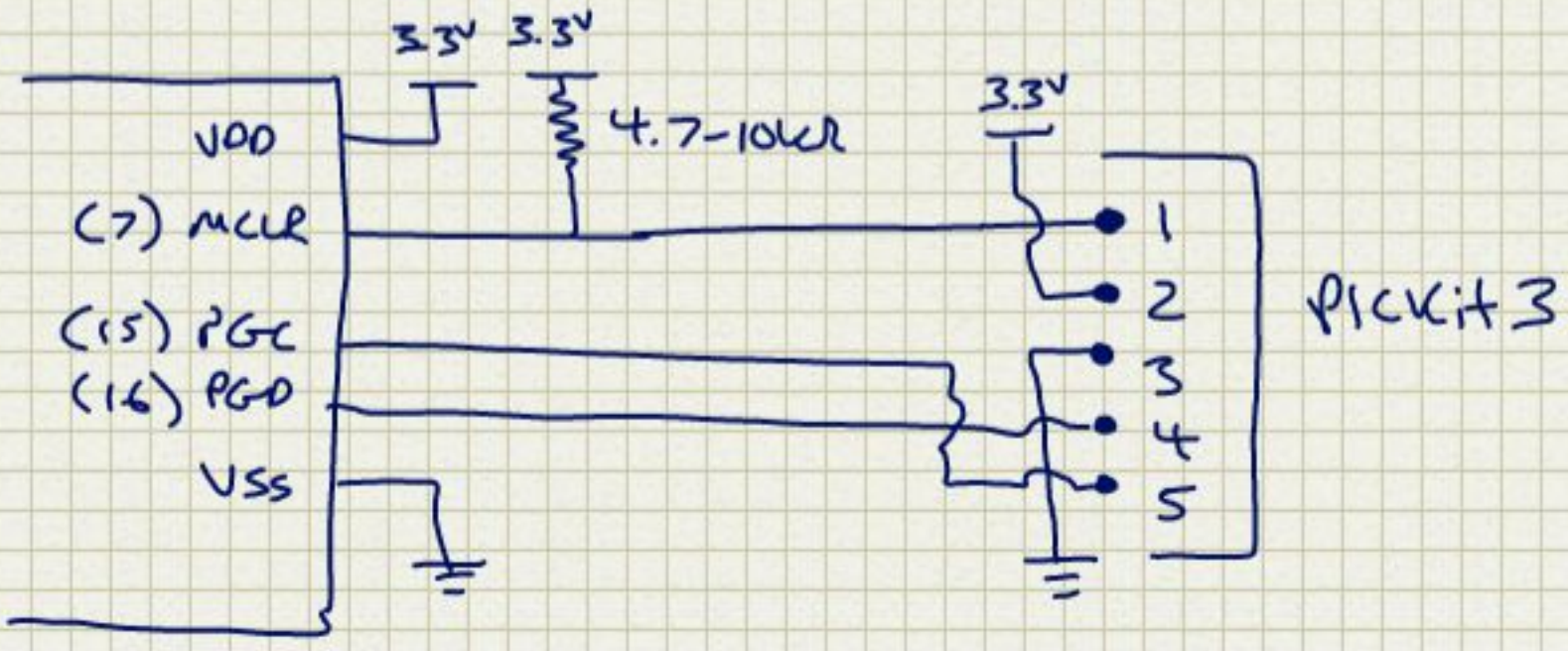
A = 5.5mm

B = 2.1mm

C = 9.5mm

PICKit 3

- ICSP req's wiring of PGECx/PGEDx pins
  - ↳ Section 27.0 → see PICKit3 Manual
  - ↳ use board (NOT debugger) to provide pwr
- Standard connections w/ PICKit:

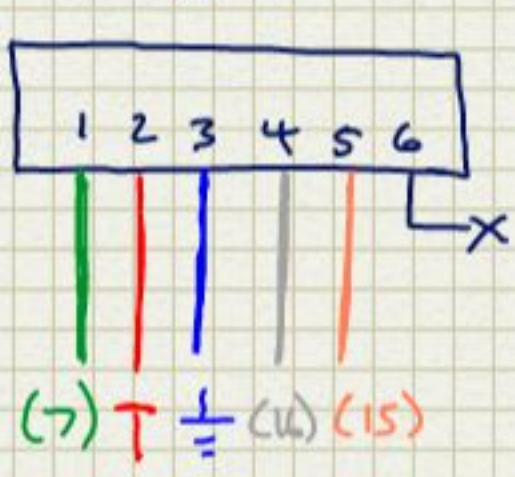


* DO NOT : ① pull-up PGC, PGD
② use caps on PGC, PGD
③ use caps on $\overline{MCLR}$
④ use diodes on PGC, PGD

↳ need to revise $\overline{MCLR}$ based on this

- using PGEC/PGED1, config correctly
(ICS configuration bits)
→ see Ch 4 of PICkit 3 Guide

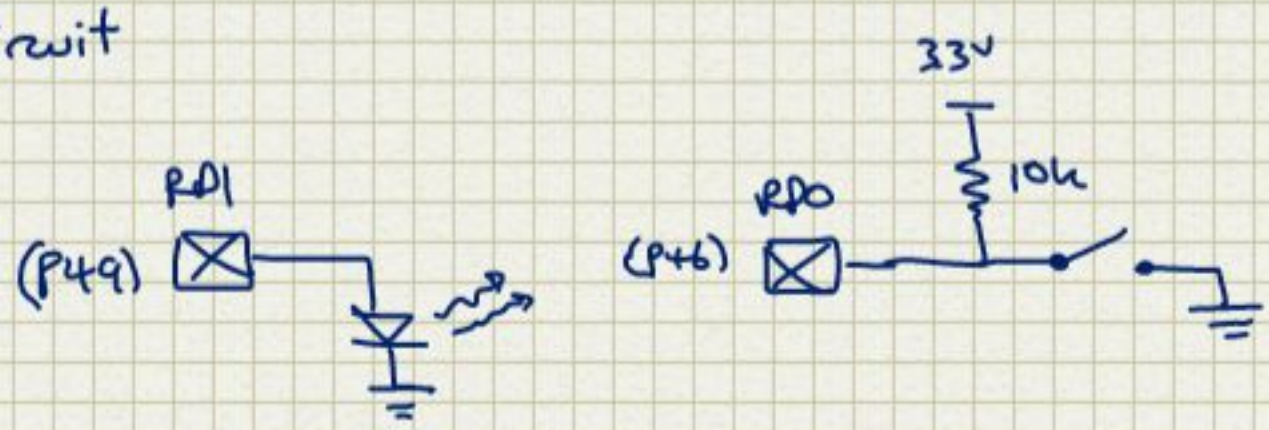
- wire coloring:



(PICkit 3)

October 15, 2012

Test Circuit



* no ANSEL needed for these bits!

PORTB, PORTD reg's → use my 478 code as ex

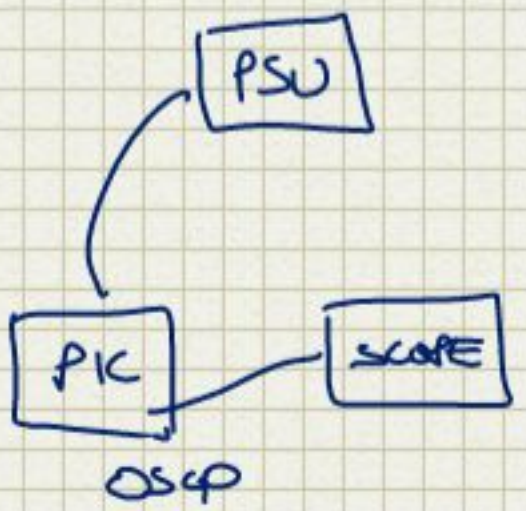
Oscillator Settings

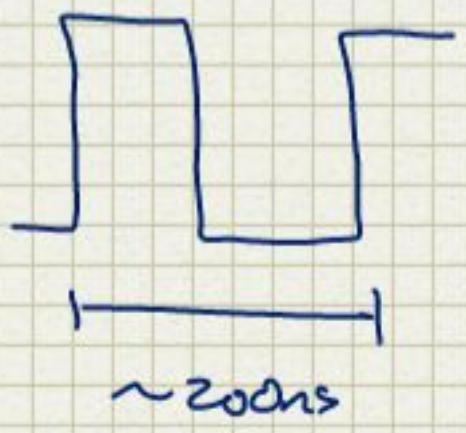
October 18, 2012

- 8MHz internal, 32 MHz external osc
- overall layout, see Fig. 8-1 (p. 137)
  - ↳ use Primary Oscillator (POSC) on OSCI/OSCO
  - ↳ internal, use FRC
- Default: FRC w/ no postscales
  - ↳ POSCMD = <11>, FNOSC = <000>
- OSCO pin determined by OSCIO FCN bit
  - ↳ defaults to OSCO
- EC OSC w/ no PLL (Fosc/2)
  - ↳ POSCMD = <00>, FNOSC = <010>
- OSCCON reg, leave alone for now (dyn clk changes

- Internal
  - ↳ set RCDIV = <000>
- OSCO = RA0

Test Circuit





fixed

f = ~5MHz

* expect $\frac{8\,MHz}{2} = 4\,MHz \rightarrow 250\,ns$ (calibration error)

Result

+ w/ updated code, works! ⇒ light blinks!

October 19, 2012

USB Friend

- no driver needed for Linux; just plug in!
- verify COM / driver install
  - ↳ appears as "/dev/ttyUSB#" in Terminal
- PIC uses TX/RX w/ RTS/CTS for ctl (see p. 24)
- Baud Rate
  - ↳ BRGH = 0 (low-speed), = 1 (high-speed)
  - ↳ $F_{CY} = F_{OSC}/2$ (Choose F_{OSC} = 32MHz)
  - ↳ FTDI req's baud rate : 183 baud – 3Mbaud
    - → Baud Rate = $\frac{3000000}{(n+X)}$

      $n = 2$ to 16,384

      $X = 0$-1 decimals
  - ↳ PIC, w/ BRGH = 1, max is

$$\text{Baud} = \frac{F_{CY}}{4 \cdot (U_x BRG + 1)} \xrightarrow{0} = \frac{16\text{MHz}}{4} = 4\text{Mbaud}$$

Choose: $U_x BRG = 1$, $F_{CY} = 16\text{MHz}$ (PIC)

$$\text{Baud} = \frac{16\text{MHz}}{4 \cdot 2} = \boxed{2\text{Mbaud}}$$

$2000000 = \frac{3000000}{(n+X)} \rightarrow (n+X) = \frac{3}{2} = 1.5$

can't do values bt 1 and 2

Try: Baud rate = 1Mbaud

UxBRG = 4, BRGH = 1, F_{osc} = 32MHz:

PIC: Baud = $\frac{(32MHz/2)}{4 \cdot 4}$ = 1 Mbaud ✓

FTDI Baud = $\frac{(30000000)}{(n+X)}$ = 1 Mbaud

*2Mbaud ok according to FTDI app note AN232B-05

↳ Divisor = 1

- need to "pass" non-standard rate to drives
  - ↳ (Q) how in Linux?

- TX in 8-bit data mode (also 9 bit)
  - ↳ write data, pty, stop bits
  - ↳ set baud rate in UxBRG reg
  - ↳ set up TX/RX int en/priority bits
  - ↳ en UART
  - ↳ set UTXEN bit

↳ write data byte to lower byte of UxTXREG
↳ can also set data byte, then UTXEN = 1
↳ TX int ctl bit gen'd based on UTXISELx

* Break and Sync TX sequence (p. 227)

- RX in either mode
↳ set up UART (like TX)
↳ enable UART
↳ RX int gen'd when get data based on URXISELx
↳ Read OERR for overrun err
↳ Read UxRXREG
- use UEN<1:0> bits to ctl $\overline{CTS}$, $\overline{RTS}$
- UxMODE Reg
↳ UARTEN (b15) = 1 (UART enabled)
↳ RTSMD (b11) = 0 (flow ctl mode)
↳ UEN (b9:8) = 10 (TX, RX, $\overline{CTS}$, $\overline{RTS}$ enabled)
↳ LPBACK (b6) = 1 (enable loopback)
↳ ABAUD (b5) = 1 (auto baud measurement)
↳ BRGH (b3) = 1 (high speed mode)
↳ PDSEL (b2:1) = 01 (8-bit data, even pty)

(*10.4)

- UxSTA Reg
↳ UTXEN (b10) = 1 (TX enabled)

Port Remapping:

- use UART3 for USB (0 = GSM, 1 = GPS)
- use regs
  - ↳ IN → set function to pin #
  - ↳ OUT → set pin # to function # → U3TX = 28, U3RTS = 29
- REGS
  - ↳ RPINR17 - 0x0300 (RP3)
  - ↳ RPINR21 - 0x0B00 (RP11)
  - ↳ RPOR6 - 0x001C (RP12)
  - ↳ RPOR2 - 0x001D (RP4)

28 = 16+8+4
29 = 16+8+4+1
11100 = 1C
11101 = 1D

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- try std baud rate, got no response from chip
  - ↳ bad soldering?

(Q) Disconnect 3.3V out → main board?

Choose Baud = 115200

$$U\times BRG = \frac{F_{cy}}{4\cdot Baud} - 1 = \frac{(16\times10^6 Hz)}{4(115200)} - 1$$

$$= 34.7\bar{2} \rightarrow \text{choose } 35$$

$$Baud = \frac{(16\times10^6 Hz)}{4\cdot(35)} = 114285 \text{ baud}$$

$$\%\ error = \frac{114285 - 115200}{115200} \times 100\% = -0.79\%$$

BRG = 35d = 32+2+1 = 0x100011 = 0x23

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Priority Issues

- pin functions listed in terms of priority
  - P46 = DMH → USB PU control output, digital O
  - P44 = SCL1
  - P43 = DPLN/SDA1 → USB PD
  - ↳ need to set TRISx correctly or fixed peripheral
  - ↳ needs to be configured in digital mode
- disable USB, SPI1?
  - ↳ USB disabled by default
  - ↳ SPI disabled by default

I/O dirs and settings

P46 = RD0 → INPUT
P45 = RP11 → OUTPUT
P44 = RD10 → INPUT
P43 = RP9 → OUTPUT

```
TRISDbits.TRISD11 = 0;
"         " TRISD10 = 1;
"         ".TRISD9 = 0;
"         ".TRISD0 = 1;
```

- no ANSEL worries on PORTD!

LATD = 0 → bring all outputs low (BEFORE setting TRIS!)

TODO: fix baud rate (Fosc setting)
get oscillator!

FIX: using 8MHz Fosc (FRC) for now, NOT 32MHz!

$$F_{cy} = \frac{8MHz}{2} = 4MHz$$

$$U_xBRG = \frac{F_{cy}}{4 \cdot baud} - 1$$

$$= \frac{(4 \times 10^6 Hz)}{4(115200)} - 1 = 7.68 \rightarrow 8$$

$$Baud = \frac{F_{cy}}{4 \cdot U_xBRG} = \frac{(4 \times 10^6 Hz)}{4(8)} = 125000 \text{ baud}$$

$$\% \text{ error} = \frac{125000 - 115200}{115200} \times 100$$

$$= 8.51\%$$

WORKS! → issues, drivers?

Fastest: ~~$Baud = \frac{F_{cy}}{4}$~~ = 1MBaud