

# The FOX-1 IHU Emulator

Or

## Making Good Use of Cheap Boards

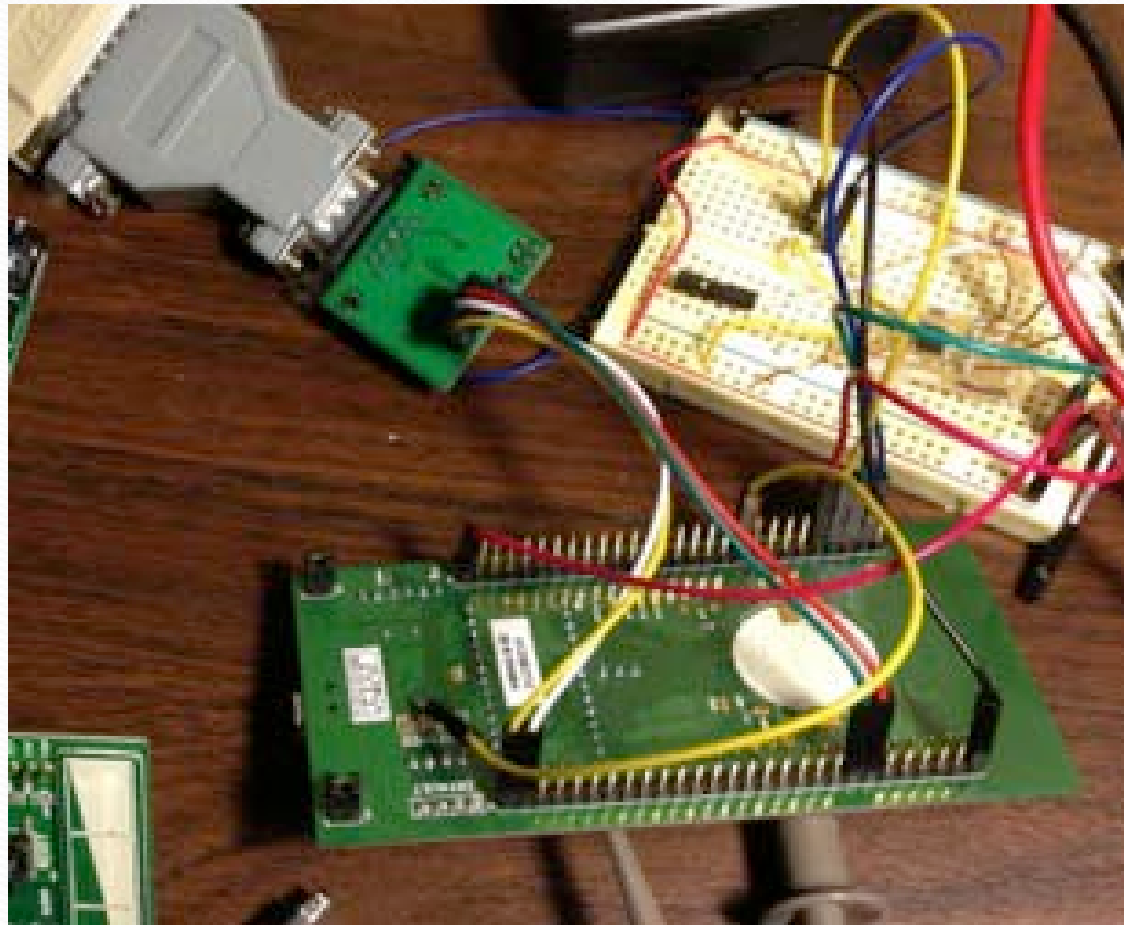
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# You Need Hardware to Write Software

- Fox Software Team started out using evaluation cards
- They are cheap!
- Nice but needed connections to additional h/w for developing.
- We ended up with a rat's nest



# Beginning of Rat's Nest

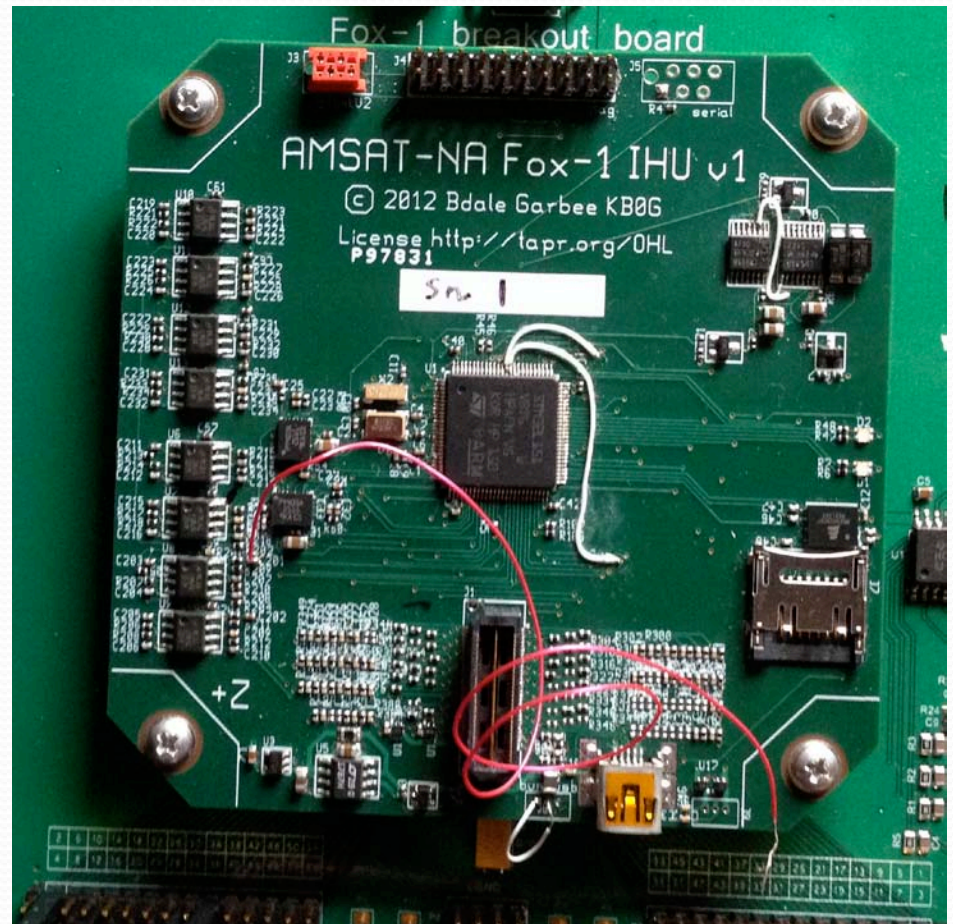


# You Need The Sat Bus To Integrate with a Satellite!

- Eventually we need to integrate the software and hardware with the rest of the satellite.
- Each board is interconnected with the satellite stacking bus.
- How do we do integration testing of the software?

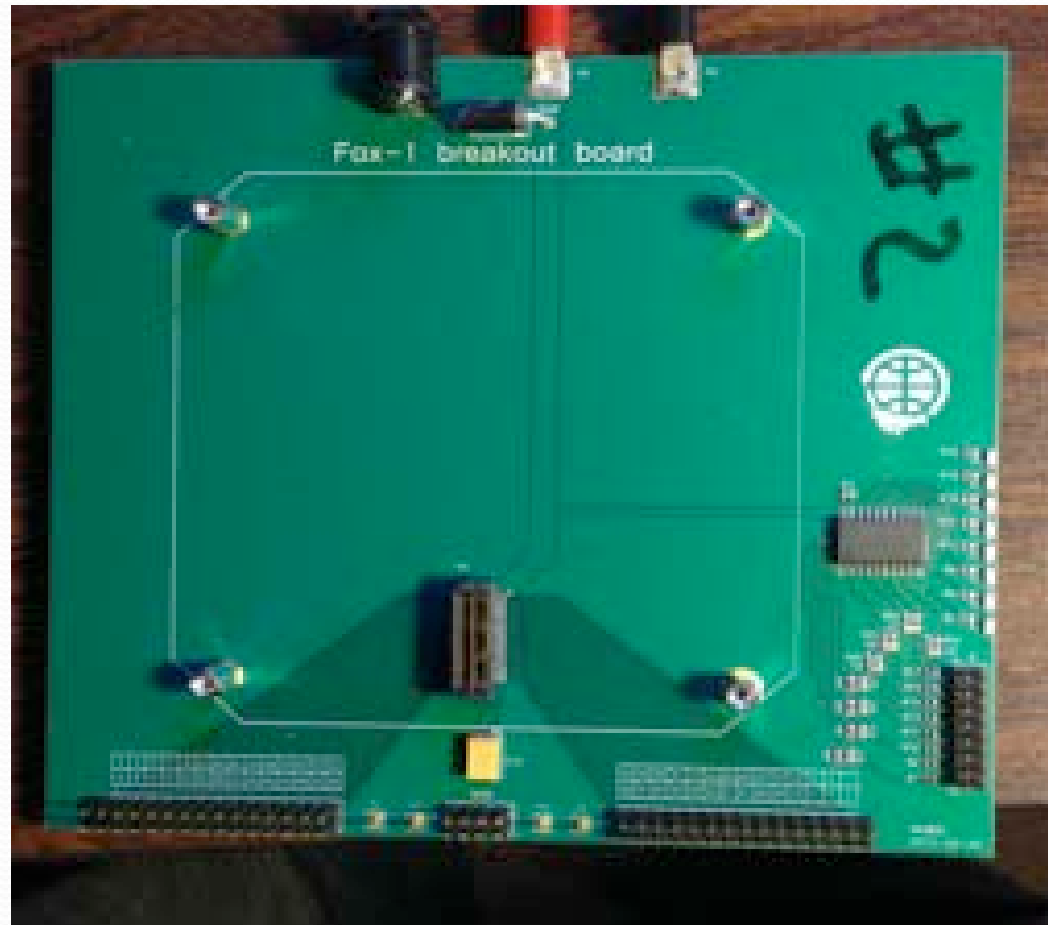
# Obvious Integration Answer

- Use an IHU Prototype!
- Problem: Only one IHU prototype exists!



# Use Discovery and Breakout Board

- Here is the bus breakout board
- We could jump from Discovery to header pins.
- Talk about a rat's nest!
- But maybe we are getting closer!



# The Next Great Idea

- Build a “motherboard” to plug Discovery into
- Install rat’s nest parts on the board
- Run satellite bus connections to ribbon cable headers
- Connect “motherboard” to other satellite boards via ribbon cable!
- Now all I have to do is design a board which we now call
  - *THE IHU SIMULATOR*



# IHU Simulator Requirements

- Can be powered by same means as satellite stack (~3.6V)
- Can be powered by USB to Discovery card
- Provide +3V for external sensor power
- Connect MCU signals to satellite bus via ribbon cables
- Provide an MRAM/FRAM on the SPI bus



# A Few More non-IHU Requirements

- Allow for development of PSU software (assuming PSU will use the same processor) before PSU is available
- Allow for development of battery card telemetry collection software before battery card is available
- Board must be buildable by someone like me

# General Design

- Room for two Discovery cards (IHU and PSU)
- FRAM/MRAM chip on board
- ADS7828 A/D converter chip (battery card) on board
- Design with through-the-hole components!

OOPS!

- FRAM and ADS7828 are both surface mount!

# Dealing with Surface Mount

- The FRAM part was big enough. I did some testing and I could solder it.
- Mike McCann, KB2FMG found “Prototype Advantage”, a company that mounts SMT chips on a DIP package!

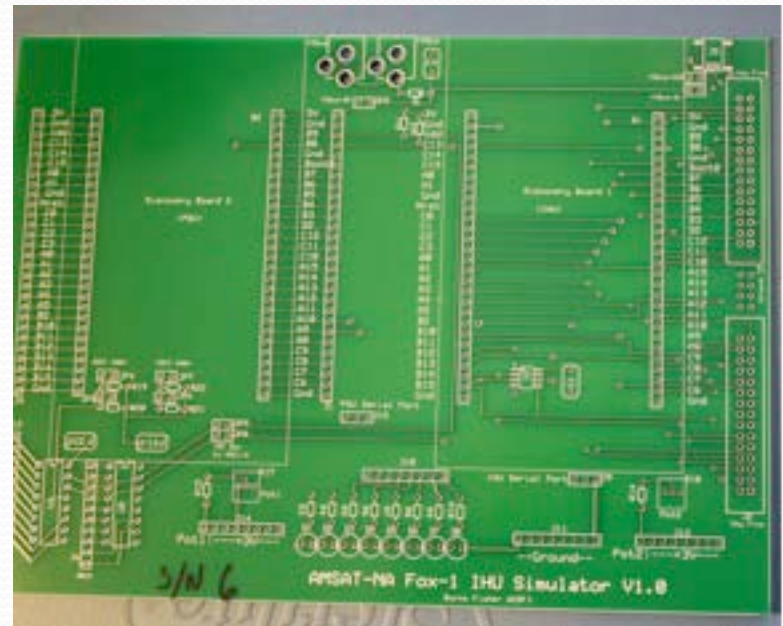


# Tools

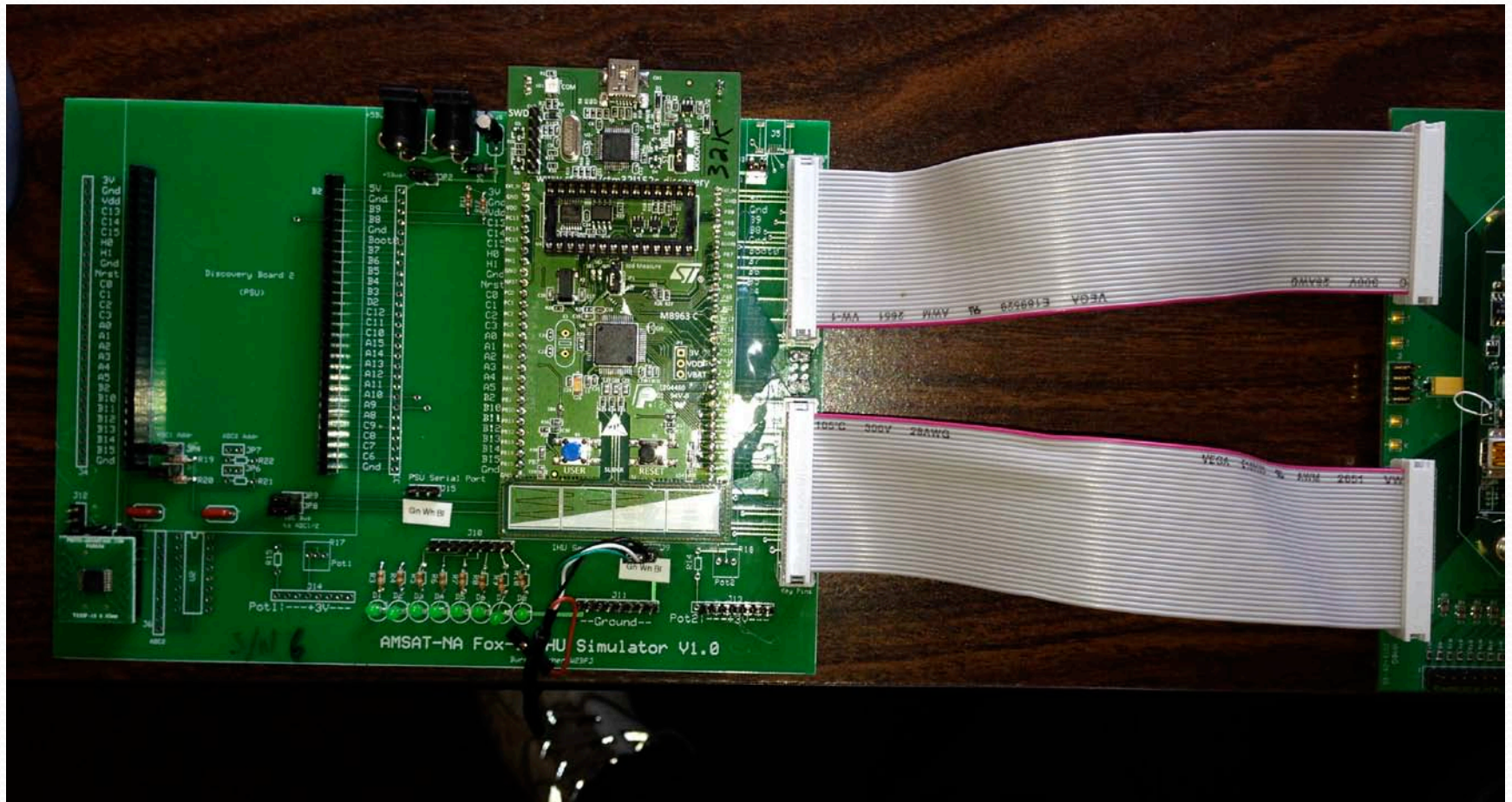
- ExpressSCH and ExpressPCB
  - Create schematic and PCB layout linked together
  - Can touch a pin in ExpressPCB to see what other pins should be connected.
- CutePDF – Create a PDF file on Windows by printing to a virtual printer
- ExpressPCB Yahoo group for component libraries
- xCheck – Written by Yahoo group member to check all nets for extra/missing connections, design rules, etc.

# “Ship it”

- Do lots of checking with paper/pencil, xCheck, eyeball!
- Do lots of checking with paper/pencil, xCheck, eyeball!
- Do lots of checking with paper/pencil, xCheck, eyeball!
- Repeat
- Finally...send it out to ExpressPCB.com over the internet and a week later:
- All we need to do is build it!



# And The Result...



# Stuff I'm Not Telling You

- In the paper, you can see
  - Some intermediate steps in my thinking
  - More about designing the PCB
  - The ExpressXXX schematic and PCB layout
  - Some of the errors I made despite the quintuple checking
  - Changes to bus specs after the board was built

# Conclusion/Lessons

- Designing a nice, useful PCB is easily within the realm of a newbie
- There are LOTS of free software tools and (not free) services available
- Expect to make mistakes; expect the design to change
- *Cheap evaluation boards can leveraged to create a complex device with a relatively simple PCB*



# Thanks!

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