Bring openwifi to PYNQ-Z1 with ultra low cost

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About Me (@regymm)

- Physics undergrad finished last year
- FPGA, PCB design, RISC-V, osdev, scavenge & tweak, NetHack, webcomic…
- SDR: too interesting to ignore…
Today

- Background that I don’t understand much
- My work: openwifi to PYNQ-Z1
- About “modern” hardware DIY at home
Background

- Xilinx ZYNQ + ADI AD936X is very capable
- 7010 CLG225 + AD9363 => PlutoSDR
- 7020 CLG400 above + AD9364 => openwifiSp
Background

• Price is a problem
  - Zedboard + FMCOMMS3 $1300
  - ADRV9364-Z7020 + Carrier $800
  - ANTS DR E310 $300
  - PlutoSDR $150
PYNQSDR

- PYNQ-Z1 $200?
  - Do I really need another ZYNQ for SDR?
  - Or an extension can made it?
PYNQSDR

- AD936X requirements
  - ~21 GPIO at 1.8V/2.5V
  - 16 LVDS diffpairs @ ~120 MHz DDR
- What PYNQ-Z1 has
  - ~49 GPIO at 3.3V, poorly routed
  - 2x HDMI, each 4 diffpairs, 50R* pullup termination
  - 2x PMOD, each 4 diffpairs w/ 200R* series and ESD diodes*
    *can be removed/hacked but I don’t want to
PYNQSDR

- AD936X requirements
  - ~21 GPIO at 1.8V/2.5V
  - 16 LVDS diffpairs @ ~40 MHz DDR

- What PYNQ-Z1 has
  - ~49 GPIO at 3.3V, poorly routed
  - 2x HDMI, each 4 diffpairs, 50R* pullup termination
  - 2x PMOD, each 4 diffpairs w/ 200R* series and ESD diodes*

*can be removed/hacked but I don’t want to

*Hack 9363 to 9364 is bad but...*
PYNQSDR

- RF frontend based on kangyuzhe666/ZYNQ7010-7020_AD9363
Firmware porting based on ANTS
- checklist: adi-hdl(IO, ps7, xdc), u-boot, kernel, dts
- Stick to 1 RX 1TX mode (TX can run ~50 MHz DDR at most)
- ... and afaik everything works
  - Openwifi 5G hotspot/client
  - GQRX FM
  - ADS-B
PYNQSDR

- Other boards?

4 PMODs RX & TX, 5\textsuperscript{th} PMOD => 8 IOs, MIPI => 8 Ios, MIO?

Picture from digilent.com

Some 42 PL IOs, 100 M Eth too bad

Picture from https://github.com/xjtuecho/EBAZ4205
About “modern” HW DIY at home

- Manufacture at JLCPCB/… leaded 4-layer 0.8mm BGA should be affordable
- “Refurbished” chips on Taobao/Aliexpress
- Soldering iron(936 or hakko T12 clone) + heatgun + solder paste + flux
About “modern” HW DIY at home

- BGA?
Thanks!

- Dr. Jiao’s nice help & invitation to FOSDEM
- kangyuzhe666’s SDR
- Various discussion groups
Q & A

Contact
- GitHub repo for PYNQSDR: github.com/regymm/PYNQSDR
- My Twitter: @regymm0
- My Telegram: @regymm0 Channel: t.me/xtalhart

*For later viewers: it's recommended to watch the talk, many important stuffs are not shown in this slides

*Proudly made with LibreOffice