ECE 471 – Embedded Systems
Lecture 28

Vince Weaver

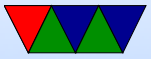
http://web.eece.maine.edu/~vweaver

vincent.weaver@maine.edu

19 November 2018

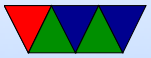
Announcements

- No class Wednesday (Thanksgiving)
- Don't forget HW#9

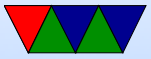


PWM

- Get around the fact that you can't get good timings w/o real-time OS
- Available on GPIO18 (pin 12)
- Can get 1us timing with PWM
  Software: 100us with Wiring Pi, probably less with GPIO interface.
- Which would you want for hard vs soft realtime?

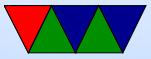


- Other things can do? Beaglebone black as full programmable real-time unit (PRU)
  200MHz 32-bit processor, own instruction set, can control pins and memory, etc.

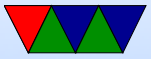


Audio Ports

- In the old days audio used to be just open `/dev/dsp` or `/dev/audio`, then `ioctl()`, `read()`, `write()`
- These days there's ALSA (Advanced Linux Sound Architecture)
  The interface assumes you're using the ALSA library, which is a bit more complicated.
- Pi lacks a microphone input, so if want audio in on your pi probably need a USB adapter.

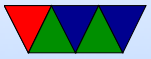


- Also can get audio out over HDMI.
- Pi interface is just a filter on two of the PWM GPIO outputs



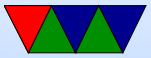
i2s

- PWM audio not that great
- i2s lets you send packets of PWM data directly to a DAC
- At least 3 lines. bit clock, word clock (high=right/low=left stereo), data
- Pi support i2s on header 5

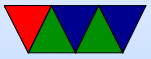


SD/MMC

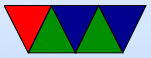
- MultiMediaCard (MMC) 1997
- Secure Digital (SD) is an extension (1999)
- SDSC (standard capacity), SDHC (high capacity), SDXC (extended capacity), SDIO (I/O)
- Standard/Mini/Micro sizes
- SDHC up to 32GB, SDCX up to 2TB



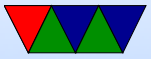
- Support different amounts of sustained I/O. Class rating 2, 4, 6, 10 (MB/s)
- SDIO – can have I/O like GPS, wireless, camera
- Patents. Need license for making.
- SPI bus mode
- One bit mode – separate command and data channels
- Four-bit mode
- 9 pins (8 pins on micro)



- Initially communicate over 1-bit interface to report sizes, config, etc.
- Starts in 3.3V, can switch to 1.8V
- Write protect notch. Ignored on pi?
- DRM built in, on some boards up to 10% of space to handle digital rights
- Can actually fit full Linux ARM server on a wireless SDIO card

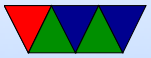


- eMMC = like SD card, but soldered onto board

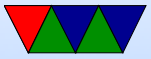


Camera Port

- The SoC has dedicated hardware for driving cameras
- 5megapixel, CSI port (Camera Serial Interface) plus i2c bus to command it.
- Can read data in parallel, directly, without needing USB overhead.
- These chips often used in cell-phones, so makes sense to have support for camera-phone without extra chip being needed.

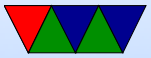


Touchscreen Display Port

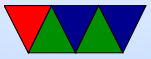


UART – serial port

- Note: Asynchronous, no clock (unlike USART)
  how do both sides agree on speed?
- Often useful on embedded boards and old systems, might be only way to reliably connect
- RS-232, originally for teletypes
- 3-15V high, -3 to -15V low
- start/stop bits, parity, bit-size
- Hardware vs Software flow control
- Speeds 300bps - 115000bps and beyond



- 50feet (15m) w/o special cables
- 3-pin version (transmit, receive ground). Also 5-pin HW flow control (CTS/RTS). Can have 2-pin version if only want to transmit
- These days often hook up USB connector
- What does 9600N81 mean?



Pi Serial Ports

- Raspberry Pi has two serial ports, good one and lousy one
  They switched them up with Pi3
- Pi does TTL (5v/0) not RS232
- Does support HW flow control, but need to activate those pins custom, is a bit complicated
- Use TTL to USB serial converter usually.
  Tell story of the prolific bricking the firmware?