ECE 271 – Microcomputer Architecture and Applications Lecture 25

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Announcements

- Don't forget course reviews
- We'll review for the final next week
- Office Hours next week might be displaced again due to Faculty Candidate visit, drop an e-mail to make sure I'll be around
- Last week of labs, next week is makeup lab

Other features of the STM32L476VG Discovery

Things We've Already Covered in Class

- 12-bit ADC (Chapter 18)
- 12-bit DAC (Chapter 19)
- LCD, 24 segments, 4 common (Chapter 25)
- 128k RAM / 1MB Flash
- Seven LEDs
  - User RED/GREEN
  - Also RED/GREEN ST-Link
  - Red for 3.3V power
  - Red for overcurrent

- ○ RED/GREEN for OTG USB
- Joystick
- GPIO (ch8)
- DMA Controller (ch11)
- NVIC Interrup Controller (ch13)
  Also EXTINT for external interrupts (ch14)
- Lots of Timers
  - ○ Advanced Timers (TIM1/TIM8) (ch30)
  - ○ General Purpose Timers (TIM2/TIM3/TIM4/TIM5) (ch31)
  - ○ More Timers (TIM15/16/17) (ch32)

- Basic Timers (TIM6/TIM7) (mostly for DAC) (ch33)
- Low Power Timer (LPTIM1) can run at any clock speed/sleep (ch34)

ST-Link

- The top half of the board is actually an ST-Link board
- Used for programming/debugging ST8/ST32 processors
- You can actually use it to program other boards/chips if you set some jumpers and hook up the proper wires

Powering

- STM manual CH5
- Can monitor power
- Can charge battery
- Low-power modes
- STM datasheet
- Can provide power multiple ways
- Battery on bottom
- External via 5V_I line
- USB via ST-LINK connector

- ○ Initial powerup only 100mA supplied
- ○ After CPU enumerates can request more, up to 300mA
- ○ If you plug in wall adapter might not work(?)
  can set JP2 in this case, but not soldered on!
- USB via FS connector

VREFBUF

- STM manual chapter 21
- Voltage Reference for ADC

MCU Current ammeter

- Can be used to measure current
- 60na to 50mA
- External (with an ammeter)
- Jumper for internal measurement too
- How does that work?
  Looks like the MFX_V2 chip, possibly via i2c
- How can you calculate power?
- Why is this useful?

RCC – reset and control clock

- STM Chapter 6
- Handles reset behavior
- Handles clock config
- Brownout?

Boot0 Line

- Can use this to skip running code flashed to the device and instead enter programming firmware

Hardware Accelerators

Cyclic Redundancy Check CRC

- STM Chapter 15
- Can do CRC calculations
- Can do ethernet or other polynomial
- These are a pain to do in software

Flexible Memory Controller

- STM Chapter 16
- Interfacing with SRAM, NOR/NAND Flash

Firewall

- STM Chapter 4
- Can protect parts of FLASH or SRAM so they can't be modified
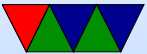- Keep buggy code from touching things it shouldn't

True RNG

- STM Chapter 27
- Analog source, fed into Linear Feedback Shift Register
- Two free-running oscillators XOR together
- Why might you want random numbers?
- Deterministic Random Bit Generator

AES

- STM Chapter 28
- AES encryption

Hash Processor

- STM Chapter 29
- Can do crypto hashes, md5, sha-1, sha-256

Device Electronic Signature

- STM Chapter 49
- Unique ID for board

Comparator / OpAmp

Comparator

- STM manual chapter 22
- Two of them
- Low-power voltage comparator

Opamp

- STM manual chapter 23
- Two of them
- Input can be connected to DAC
- Output can be connected to ADC

I/O Busses

Serial vs Parallel Busses

- Serial busses – send one bit at a time
- Parallel busses – send bits in parallel
- Which is faster? In the old days parallel was (send 8 times as many bits at a time!)
- Faster than a few MHz and other issues come in, synchronization, noise, transmission line issues, signal length, routing on circuit boards
- Old: Parallel: PATA, PCI, Parallel port
- New: SATA, PCIe, USB

USART – Universal Synchronous or Asynchronous Receiver Transmitter

- "serial port"
- STM manual chapter 40
- Board has 6 USART (USART1-3, UART4,5 LPUART1)
- 2400bps - 9Mbps
- NRZ (non-return to zero) (rs232 0=+Xv, 1=-Xv)
- Notes on serial ports (UART) – get notes from 598?
- minimum of two pins send/receive
- Synchronous mode has a CK (clock) pin

- CTS/RTS for hardware flow control
- FIFO, DMA
- Virtual COM port?
- Other things you can use it for
  - LIN (local interconnect network?)
  - Smartcard Protocol (?)
  - irDA (infrared), SIR ENDEC
  - MODBUS
- Low power uart (ch41), can run at 9600bps and listen to incoming frames in low-power mode

i2c

- STM manual chapter 39
- Has three i2c busses
- i2c, see 471 notes
- Connector CN2 has i2c on it (top left boxy thing)

SPI

- STM Chapter 42
- Has three SPI busses
- MISO/MOSI/SCK/NSS
- Use GPIOs for chip selects
- Blah, see 471 notes

bxCAN bus

- STM Chapter 46
- Controller area network
- The parts of your car communicate on this bus

DCMI Digital Camera Interface

- STM manual chapter 20
- Hooking up cameras
- Why not USB?

USB OTG FS

- STM Chapter 47
- USB on-the-go Full Speed
- USB-micro connector
- Allows devices to be either USB devices or hosts
- If a host, you can hook up devices to it like keyboards or USB keys
- If a device, you *act* like a device, so can be a keyboard, USB key, or anything else
- OTG can switch between, sort of like if you have a

cellphone and when you hook to a computer want it to appear as a disk (to transfer photos) but if you hook up a keyboard want it to be like a computer

Single Wire Protocol – SWPMI

- STM chapter 44
- Single Wire Protocol
- *not* the same as 1-wire protocol
- Used for talking to SIM chips in phones? Also contactless interfaces?
- M to S by voltage modulation
- S to M by current modulation

SDMMC (sd card)

- STM chapter 45
- 4-bit mode?

Serial Audio Interface (SAI)

- STM chapter 43
- Two of them
- Can be i2s, or AC'97, or other
- 8 to 32 bit
- FIFO
- 2-channel DMA
- Can handle SPDIF

Infrared Interface (IRTIM)

- STM Chapter 35
- TIM16 and TIM17 joined up to generate proper pulses
  TIM17 high freq carrier, TIM16 modulation envelope
- To get signal use input capture
- PB9 can be configured to sink high current of LED

External Devices

Audio DAC (note, not the internal DAC)

- CS43L22 (U13) – see notes on project
- Cirrus logic
- Connected via i2c, address 0x94
- Stereo output on audio jack
- Class D amplifier
- Beep generator

MEMS 9-Axis Motion Sensor

- Connected via SPI
- L3GD20 (U7) three-axis digital gyroscope
  - i2c or SPI
  - Tells change in position
  - Also has temperature sensor?
- LSM303C (U6) 3d-accelerometer and 3D Magnetometer
  - Free-fall detector (generate interrupt) (why is that useful?)
  - +/- 2G,4G,or 8G

○ Magnetic field +/-16Gauss

MEMS Microphone

- What is MEMS
- MP34DT01
- Hooked to DFDSM?
- L/R channel pin but seems not to be stereo, but in this case clock phase to have valid data

Quad-SPI Flash

- STM Chapter 17
- Regular SPI only transfers one bit at a time
- Quad-SPI can send 4-bits at a time
- Up to 40Mbit/so
- Can do things like erase/write flash

Touch Sense Controller

- STM Chapter 26
- Capacitive Touch Sensor
- Old STM32L152Discovery had these, metal pads

DFSDM – Digital Filter for Sigma Delta Modulator

- STM Chapter 24
- High-end DAC?
- Sort of reverse PWM? Takes analog signal and gives PWM like output

Microcontroller Clock Output (MCO)

- Can put the clock out on a pin

JTAG Debugging

- STM Chapter 48
- JTMS/JTCK/JTDI
- NJTRST

Independent Watchdog (IWDG) System Window Watchdog (WWDG)

- STM Chapters 36 + 37
- Counter counts down, if it hits 0 something was wrong and resets system
- Write special value 0x0000AAAA to re-up
- Dedicated low-speed clock in case something goes wrong with clock setup

Real Time Clock

- STM Chapters 38
- Keeps time/date
- Can set alarm
- Can handle leap years
- daylight savings (not automatic, but quick mode to add/subtract 1 hour)
- Tamper detection
  - Can have switches (cover switch) and record if someone is tampering with system

○ Also can zero out registers (secrets? Encryption keys?) if tampered