



University
POLITEHNICA
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Faculty of
Automatic Control
and Computers



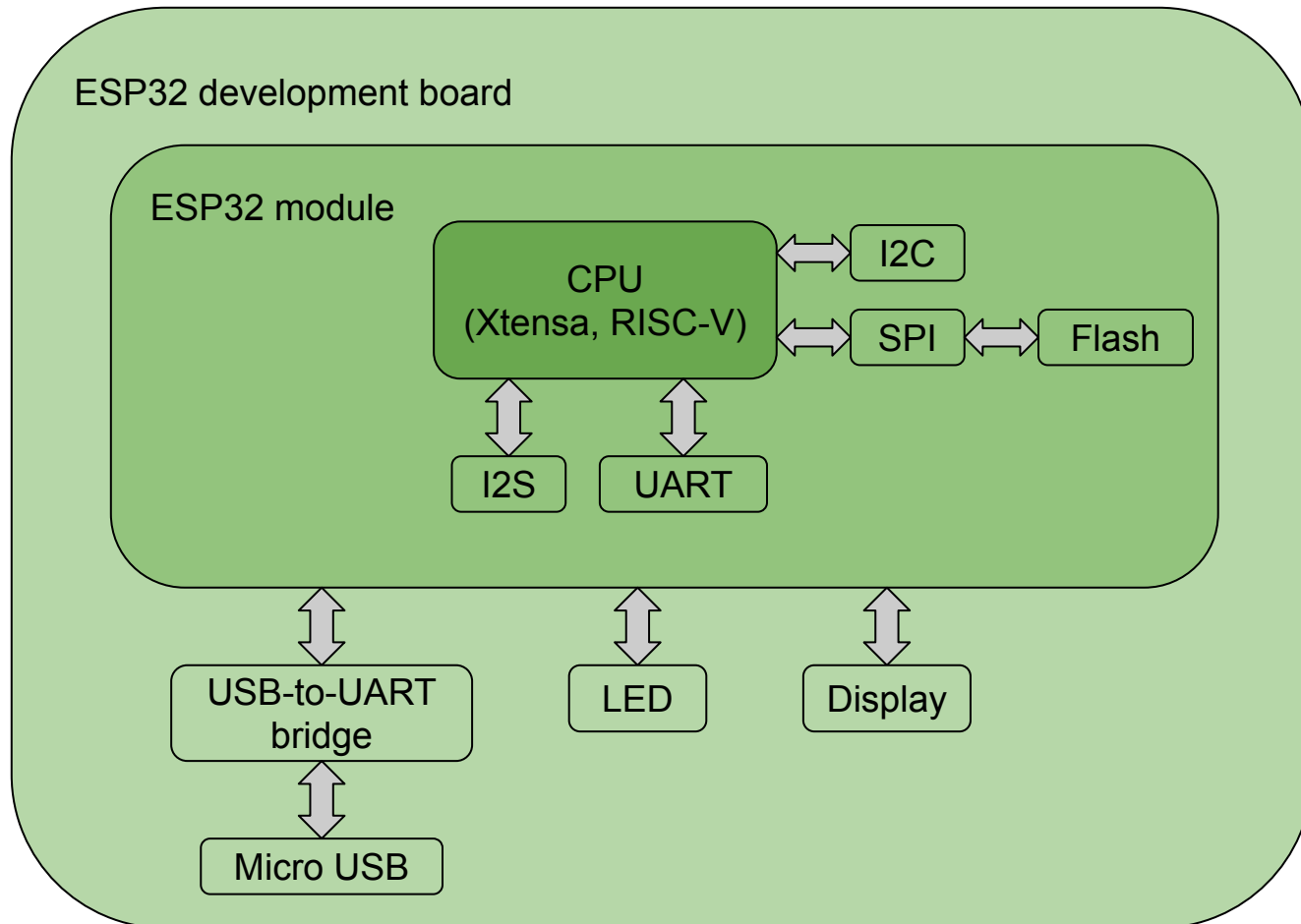
Computer Science
and Engineering
Department

Internet of Things

Lecture 9 - NuttX Demo



ESP32 Architecture



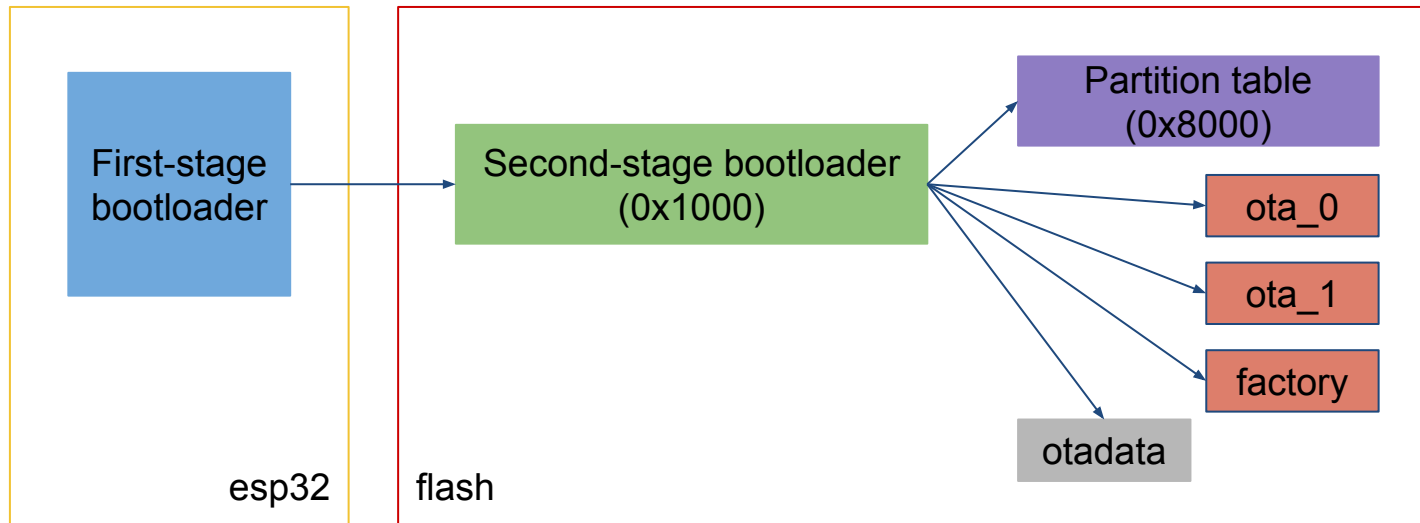


- Flat address space vs protected build
- MPU vs MMU
- Has support for built-in apps by linking a static library at compile time (libapps.a)
- Very flexible build system

```
root@vagrant:~/nuttxspace/nuttx# ./tools/configure.sh -L
qemu-intel64:ostest
qemu-intel64:nsh
qemu-armv8a:netnsh_smp
qemu-armv8a:nsh
qemu-armv8a:netnsh
qemu-armv8a:nsh_smp
qemu-armv8a:nsh_smp_tickless
qemu-armv8a:nsh_gicv2
fvp-armv8r:nsh
fvp-armv8r:nsh_smp
pinephone:lcd
pinephone:nsh
```



Flashing NuttX

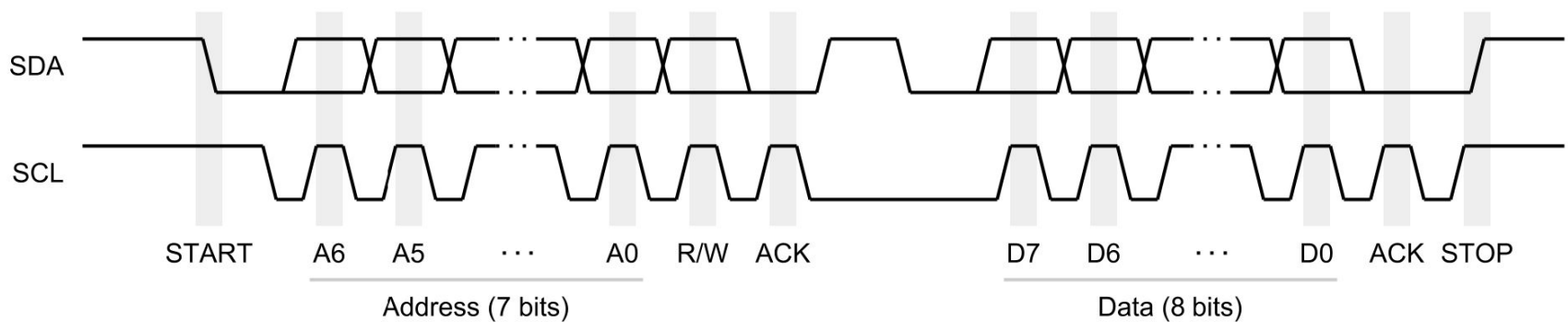


- NuttX also provides support for manually building the bootloader and the partition table
- If needed, the offset of the partition table can be changed via `CONFIG_ESP32_PARTITION_TABLE_OFFSET`



I2C 101 crash course

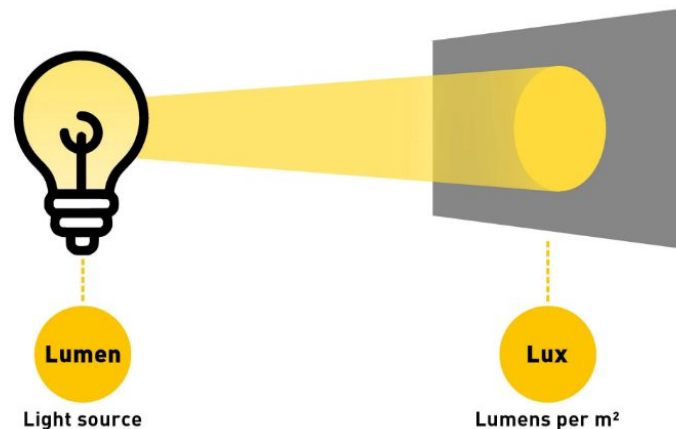
- Simple hardware protocol - uses only 2 data lines (SDA, SCL)
- Master-slave architecture
- Half duplex - data is sent bidirectionally over the SDA line





LTR308 light sensor

- I2C sensor
- How to measure light?



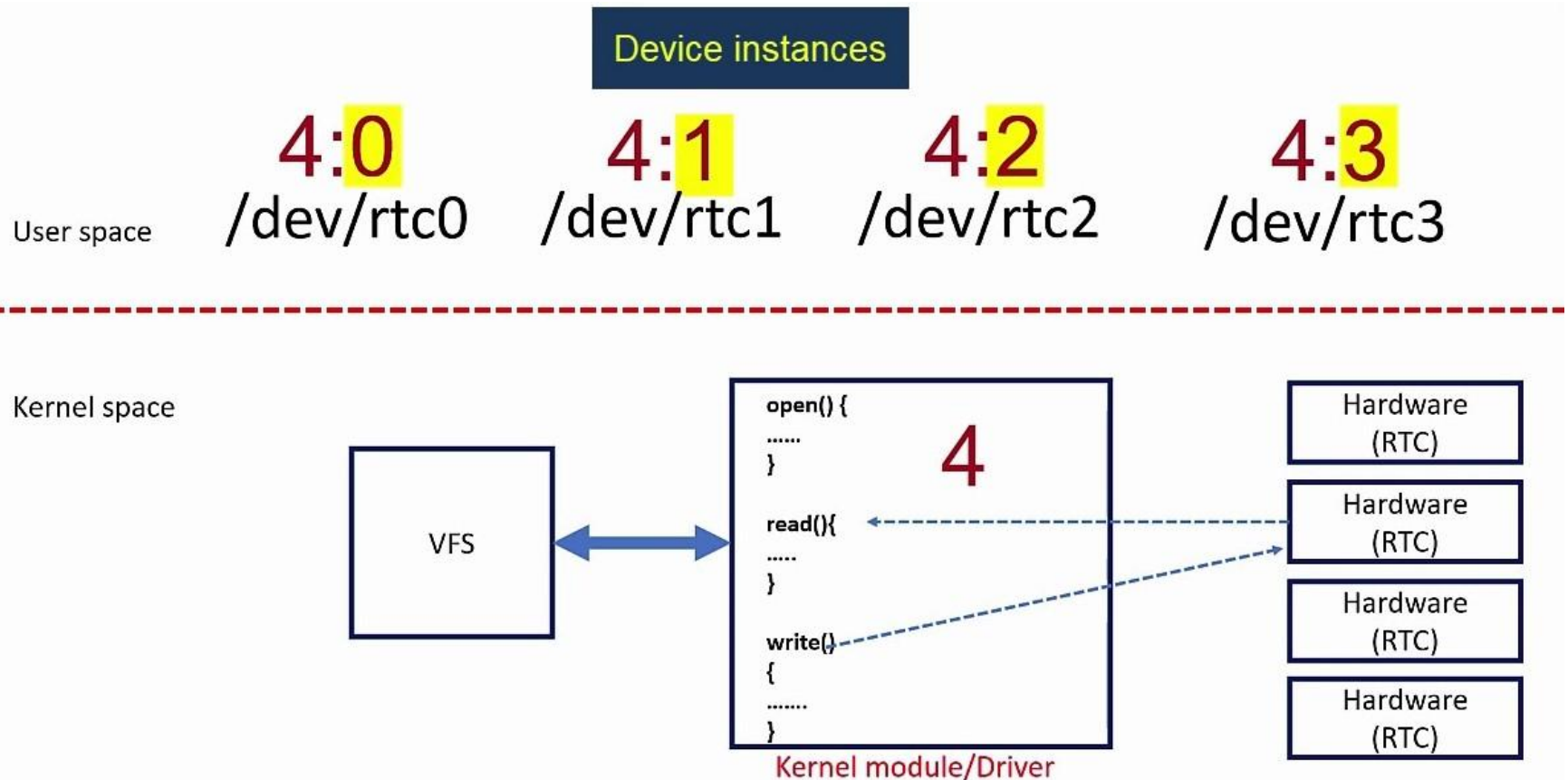
- LTR308 outputs raw data which in turn needs to be converted to lux

$$Lux_{calc} = \frac{0.6 \times ALS_{DATA}}{(GAIN \times INT)}$$



Char device drivers

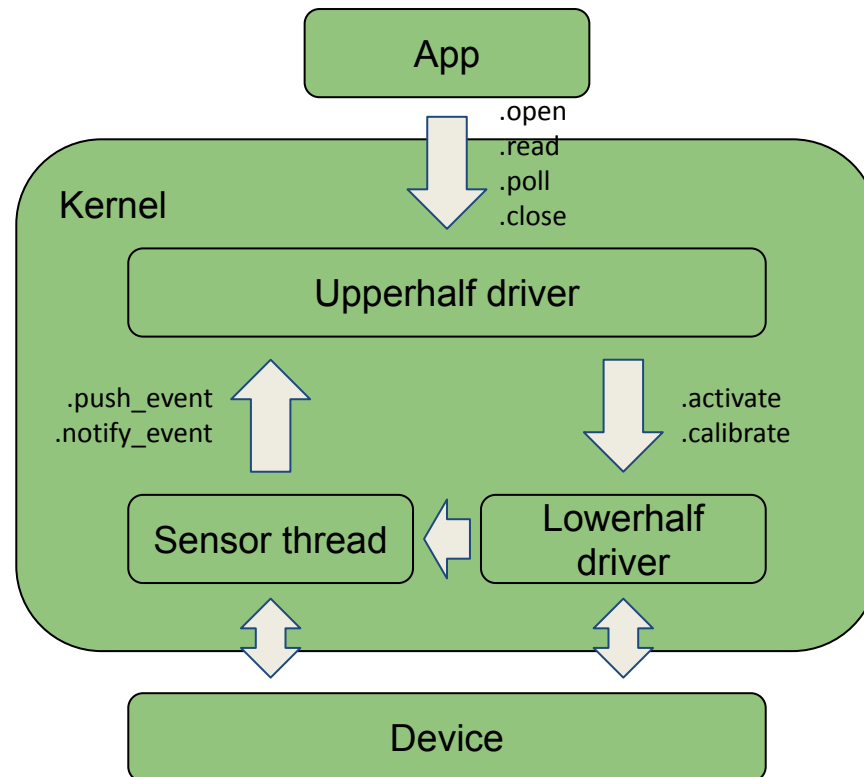
- Linux approach





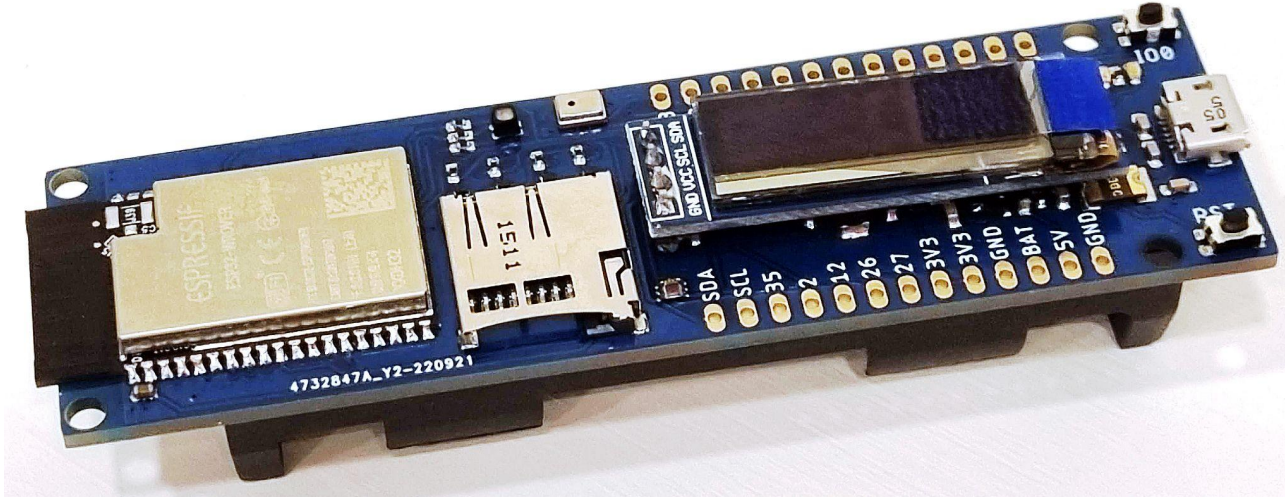
Char device drivers

- NuttX approach (LTR308 sensor)





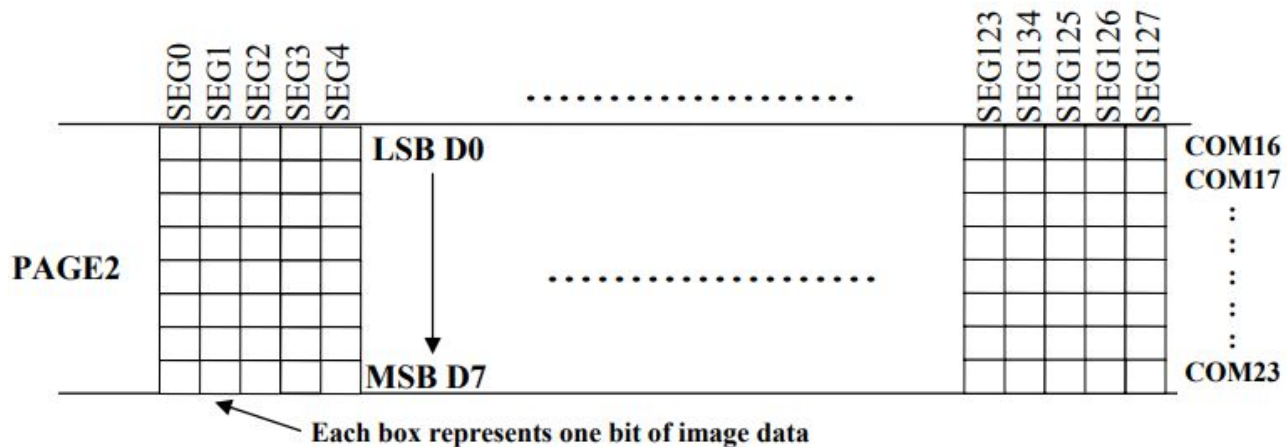
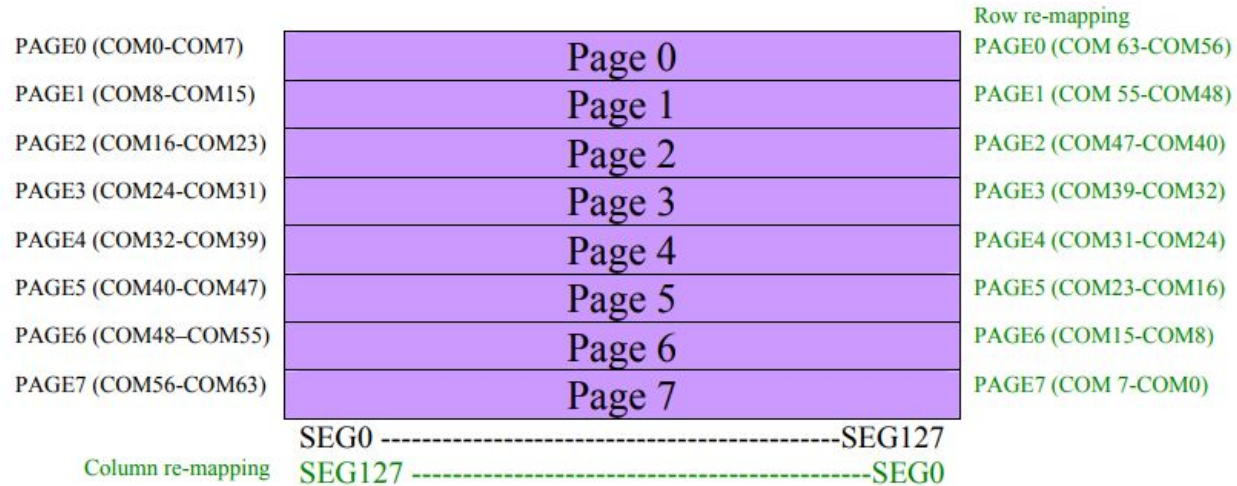
SSD1306 OLED Display



- OLED vs LCD?
- Connects through either I2C or SPI
- 128x32 resolution, monochrome (1BPP)



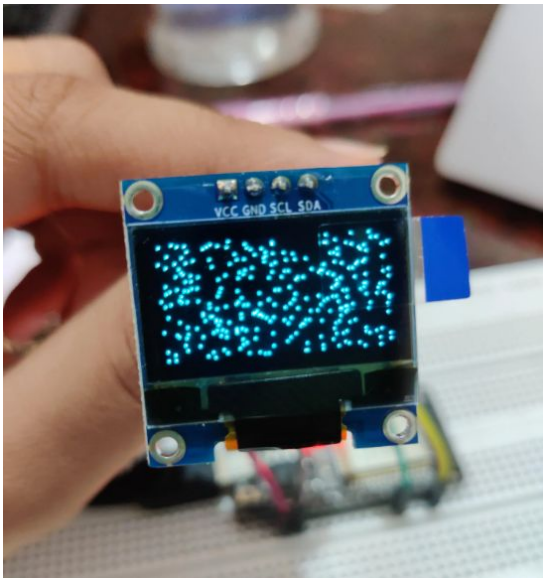
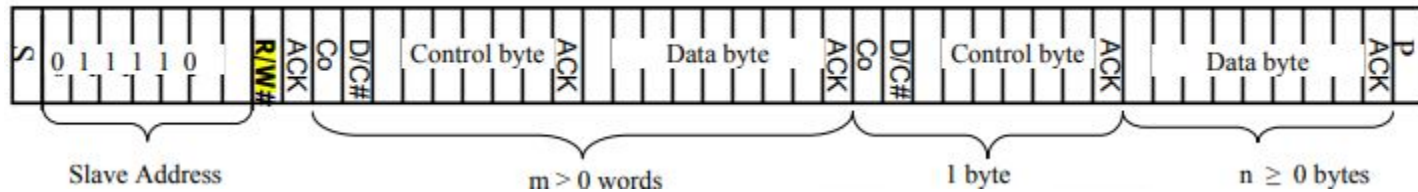
GDDRAM





I2C error

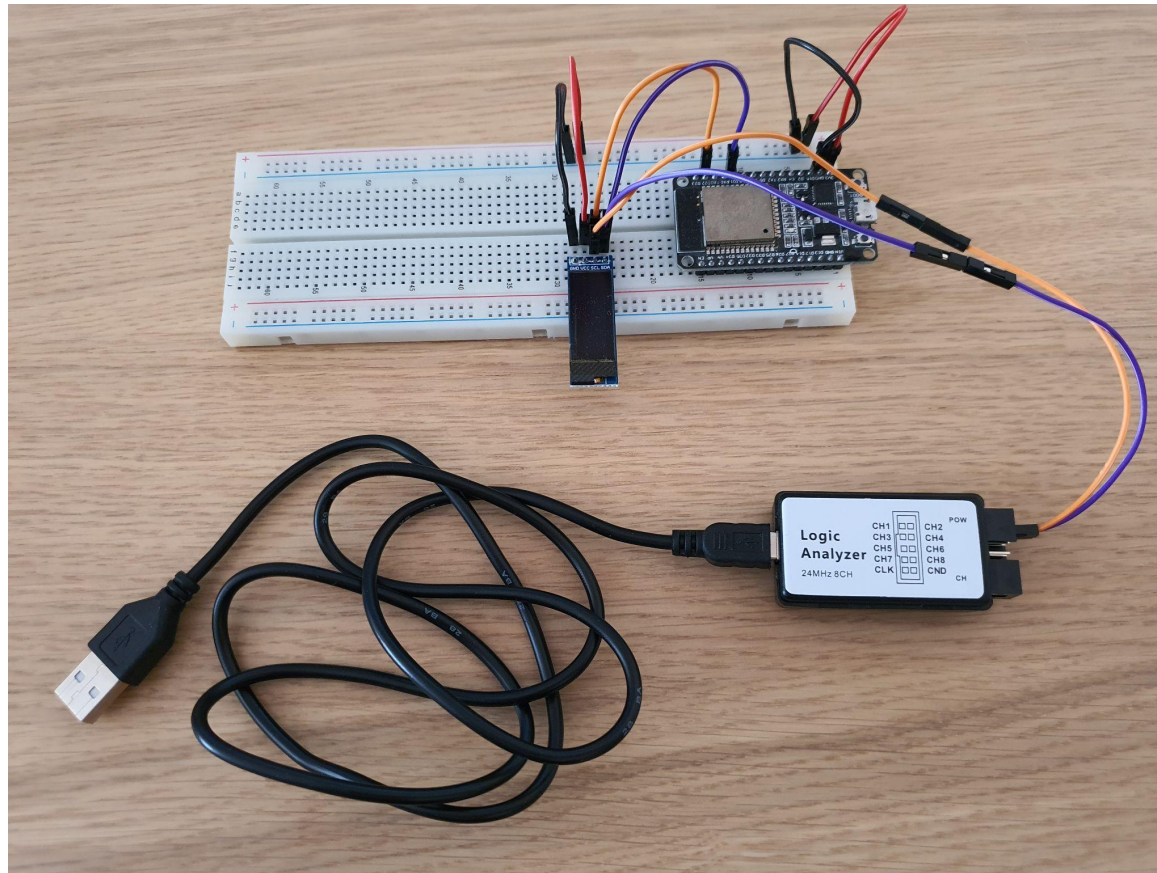
- I2C data format:



- If uninitialized, the display outputs random GDDRAM data
- At boot time, the driver should reset (clear) the display



How to debug?





Bibliography

- <https://www.lucadentella.it/en/2016/12/22/esp32-4-flash-bootloader-e-freertos/>
- <https://www.youtube.com/watch?v=QQsfuYSAQBI>
- https://optoelectronics.liteon.com/upload/download/DS86-2016-0027/LTR-308ALS_Final_%20DS_V1%201.pdf
- <https://pdf1.alldatasheet.com/datasheet-pdf/view/1179026/ETC2/SSD1306.html>