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□ 4 □	UART □□□	□□□□□□□□□□ □	□□
□ 5 □	ADC □□□	□□□□□□□□□□ □□	□□
□ 6 □	□□ + PWM	□□□□ PWM □□□□□□□	□□
□ 7 □	DMA □□	□ CPU □□□□□□□□□□	□□□
□ 8 □	I2C □□	□□□□□□□□□□ □□	□□□
□ 9 □	SPI □□□□	□□□□□□□□ SD □□□	□□□

? ?????????? 10-12 ??

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□ 10 □	CANbus □□	□□□□□□□□□□ □□	□□□
□ 11 □	RS-485 □□	□□□□□□□□□□	□□□
□ 12 □	□□ CRC □□	□□□□□□□□□□ □□	□□

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□ 13 □	FreeRTOS	□□□□□□□□□□ □□	□□□□

? ????????

? 1 ??????? + Blink LED

stm32_lesson_01_env.md

STM32CubeIDE

- STM32CubeIDE
- Nucleo-F446RC
- LED

STM32CubeIDE

- STM32CubeIDE
-
- CubeMX
- Blink LED

? 2 ??????????

stm32_lesson_02_clock.md

STM32F446

- STM32F446
- Clock Tree
- LED

STM32F446

- HSI HSE PLL
- AHB APB1 APB2
- Clock Tree
-

? 3 ??GPIO ??????????????

stm32_lesson_03_gpio_adv.md

GPIO

- GPIO
- EXTI
-

GPIO

□ □□□□

- □□□□□□□□
- □□ PWM □□□□
- □□□□□□

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- □□□□□□□□
- PWM □□□□□□□□
- PWM □□□□□□□□
- □□ LED □□□□□□

? 7 ??DMA???????????

□□ □ `stm32_lesson_07_dma.md`

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- □□ DMA □□□□
- □□ ADC + DMA
- □□□□□□□□

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- DMA □ CPU □□□□□
- □□□□□□□□
- DMA □□□□□□
- ADC + DMA □□□□□□

? 8 ??I2C ?? + DMA

□□ □ `stm32_lesson_08_i2c.md`

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- □□ I2C □□
- I2C □□□□□
- I2C + DMA □□

□□ □□□□

- I2C □□□□□□□
- SCL□ SDA □□□□□□□

- [REDACTED]
- [REDACTED]

? 9 ??SPI ?? + DMA

[REDACTED] [REDACTED] `stm32_lesson_09_13_summary.md` [REDACTED] 9 [REDACTED]

[REDACTED] [REDACTED]

- [REDACTED] SPI [REDACTED]
- SPI [REDACTED]
- SPI + DMA [REDACTED]

[REDACTED] [REDACTED]

- MOSI [REDACTED] MISO [REDACTED] SCK [REDACTED] CS [REDACTED]
- [REDACTED]
- SPI [REDACTED] I2C [REDACTED]
- [REDACTED]

? 10 ??CANbus ????????????

[REDACTED] [REDACTED] `stm32_lesson_09_13_summary.md` [REDACTED] 10 [REDACTED]

[REDACTED] [REDACTED]

- CAN [REDACTED]
- [REDACTED]
- [REDACTED]

[REDACTED] [REDACTED]

- CAN [REDACTED]
- CAN [REDACTED] TJA1050 [REDACTED]
- [REDACTED]
- Nucleo ↔ Nucleo [REDACTED]

? 11 ??RS-485 ??

[REDACTED] [REDACTED] `stm32_lesson_09_13_summary.md` [REDACTED] 11 [REDACTED]

[REDACTED] [REDACTED]

- [REDACTED]

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[REDACTED] STM32CubeIDE v1.13+ [REDACTED] <https://www.st.com/en/development-tools/stm32cubeide.html>

[REDACTED] 13 [REDACTED] Markdown [REDACTED]

[REDACTED] STM32 Nucleo-F446RC [REDACTED]

[REDACTED] USB Type-B [REDACTED]

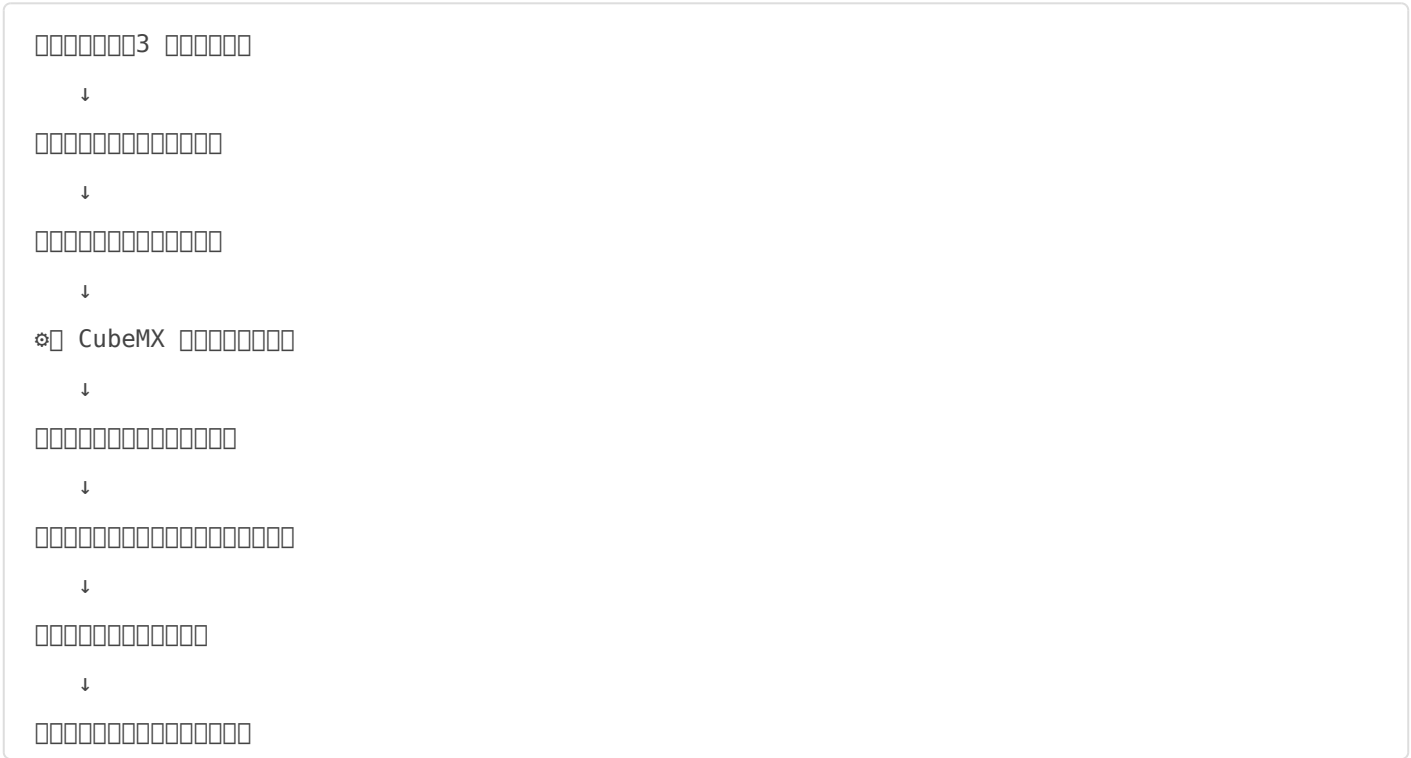
[REDACTED] ST-Link [REDACTED]

???????

- 1 [REDACTED] ✓
 - ↓
- 2 [REDACTED] ✓
 - ↓
- 3 [REDACTED]GPIO [REDACTED] ✓
 - ↓
- 4 [REDACTED]UART [REDACTED] ✓
 - ↓
- 5 [REDACTED]ADC [REDACTED] ✓
 - ↓
- 6 [REDACTED]Timer + PWM ✓
 - ↓
- 7 [REDACTED]DMA [REDACTED]
- ↓
- 8-12 [REDACTED]
- ↓
- 13 [REDACTED]RTOS [REDACTED]

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- [STM32F446](#)
- [Nucleo-F446RC](#)
- [STM32F4](#)

?????

- STM32CubeIDE
- STM32CubeMX
- STM32Cube Firmware

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- **Windows** PuTTY Tera Term Arduino IDE
- **Linux** minicom picocom
- **macOS** minicom Arduino IDE

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1. [] [] - []
2. [] [] - []
3. [] [] - []
4. [] [] - []
5. [] [] - []

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1. [] []
2. [] []
3. [] []
4. [] [] IDE []
5. [] []

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- [] [] undefined reference to 'HAL_xxx'
- [] [] HAL []
- [] [] Project → Properties → C/C++ Build → Libraries []

?????

- [] [] Failed to connect to target
- [] [] ST-Link []
- [] [] [] USB

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- [] [] [] main []
- [] [] [] while(1) []

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1. □□□□□□□□ & □□□□□□
 2. □□ [STM32](#) □□□□□□
 3. □□□□□□□□
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□□□□□□ **CC-BY-SA 4.0** □□□□ □□□□

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- □□□□ STM32 □□□□
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Revision #2

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