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Empty check mechanism on STM32 microcontrollers

Empty check mechanism

- Present on some STM32 families
- MCU boots into System memory if content of the first address in flash is empty
- Simplifies programming of virgin parts
- Can cause issues if Programming on assembled board (system bootloader configures multiple GPIO in output mode)


Common problems

- Risk of overconsumption or even short circuit if Bootloader pins are connected to GND or VDD
- The code in User flash doesn't run after programming and resetting via Reset pin

Empty check mechanism by STM32 Series

- STM32WB
- STM32G0
- STM32L4+
- STM32F04x
STM32F09x
STM32F070x6
STM32F030xC
- STM32L011x/ STM32L021x
- STM32L41x/ STM32L42x
STM32L43x/ STM32L44x
STM32L45x/ STM32L46x

STM32 Series	Empty check	Arm Cortex®
STM32 F0	Depends on device part number	M0
STM32 F1		M3
STM32 F2		M3
STM32 F3		M4
STM32 F4		M4
STM32 F7		M7
STM32 L0	Depends on device part number	M0+
STM32 L1		M3
STM32 L4		M4
STM32 L5		M33
STM32 H7		M7/M4
STM32 G0	Available on all devices	M0+
STM32 G4		M4
STM32 WB		M4/M0+

 Available on all devices

 Depends on device part number

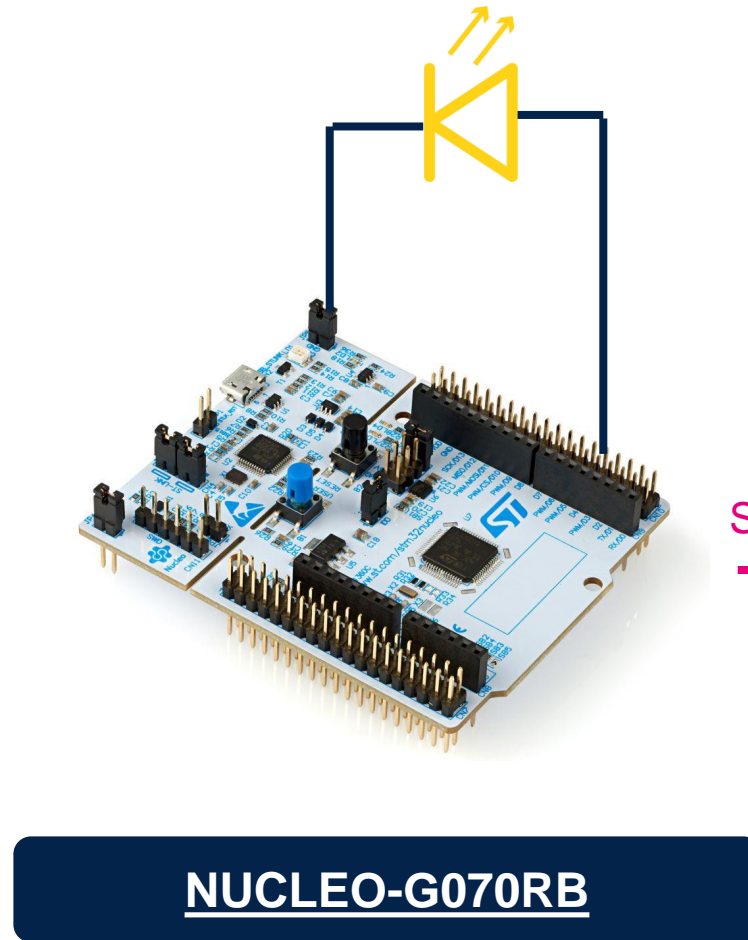
Solution

- To prevent booting into System memory user shall
 - Keep nRST signal low to keep the device under reset and power the device
 - Connect with debugger Under reset. It enables connection to the target using a reset vector catch before executing any instructions, in other words before System bootloader initializes any peripherals and GPIOs
 - Program User flash
 - Clear the Empty check
 - a) Power cycle
 - b) Option byte relaunch
 - c) Clearing Flash_ACR:EMPTY (possible only on STM32G0 and STM32WB)

Hands-On

Flashing empty STM32 without entering System bootloader

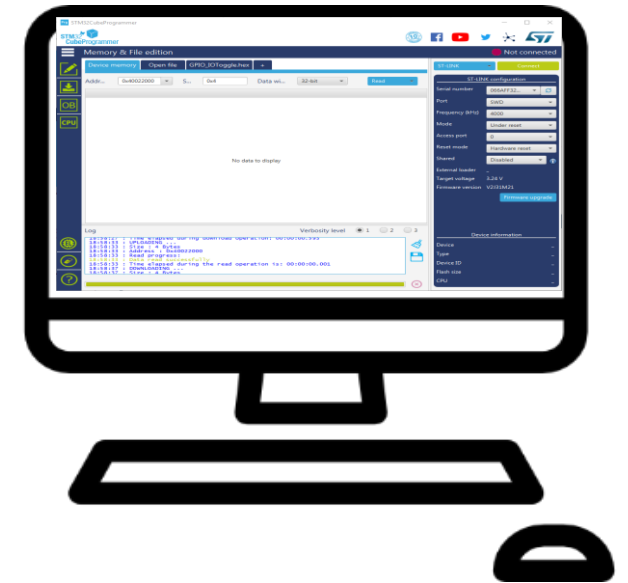
- Flash empty MCU over SWD/JTAG without entering System bootloader
- When System bootloader is entered it configures all communication interfaces including USART1_TX pin on PA9 -> Yellow LED is ON



ST-LINK

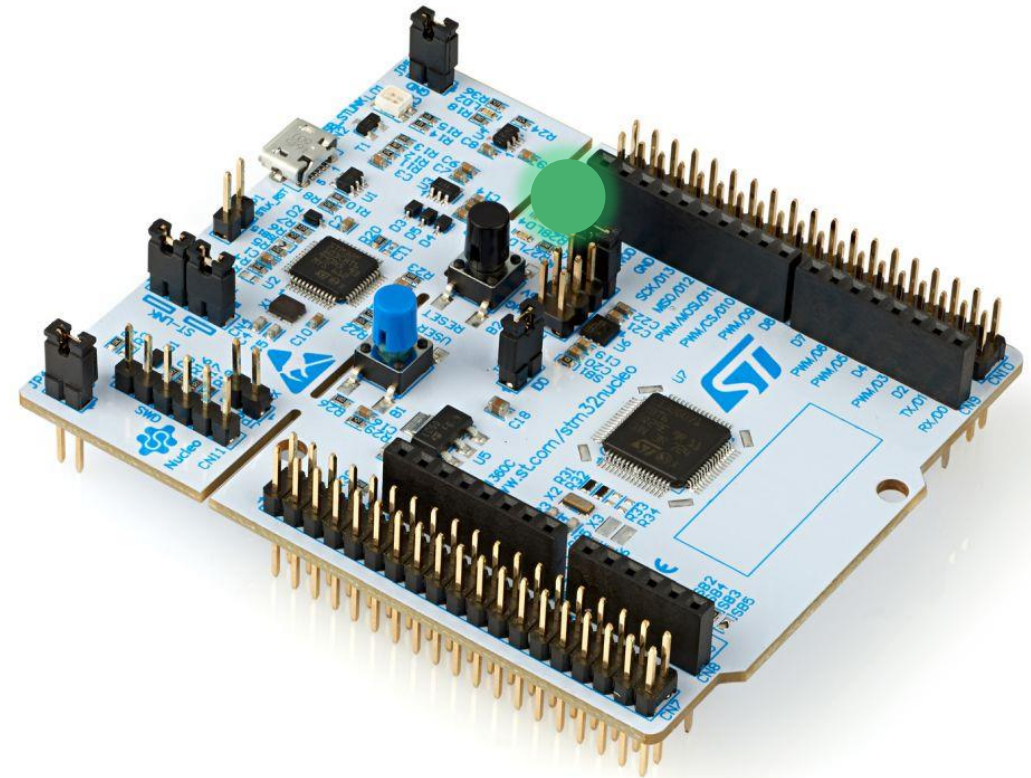


Cube Programmer



Flashing empty STM32 without entering System bootloader

- Connect under reset
- Flash the test binary “Green LED blinking”
- Apply one of the following
 - Power on reset
 - Execute Option byte launch
 - Clear FLASH_ACR:EMPTY (only possible on STM32G0)



References

- AN2606 STM32 microcontroller system memory boot mode ([link](#))

Thank you

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