



1. Description

1.1. Project

| | |
|-----------------|--------------------|
| Project Name | robotic_arm |
| Board Name | NUCLEO-F446RE |
| Generated with: | STM32CubeMX 6.12.1 |
| Date | 03/19/2025 |

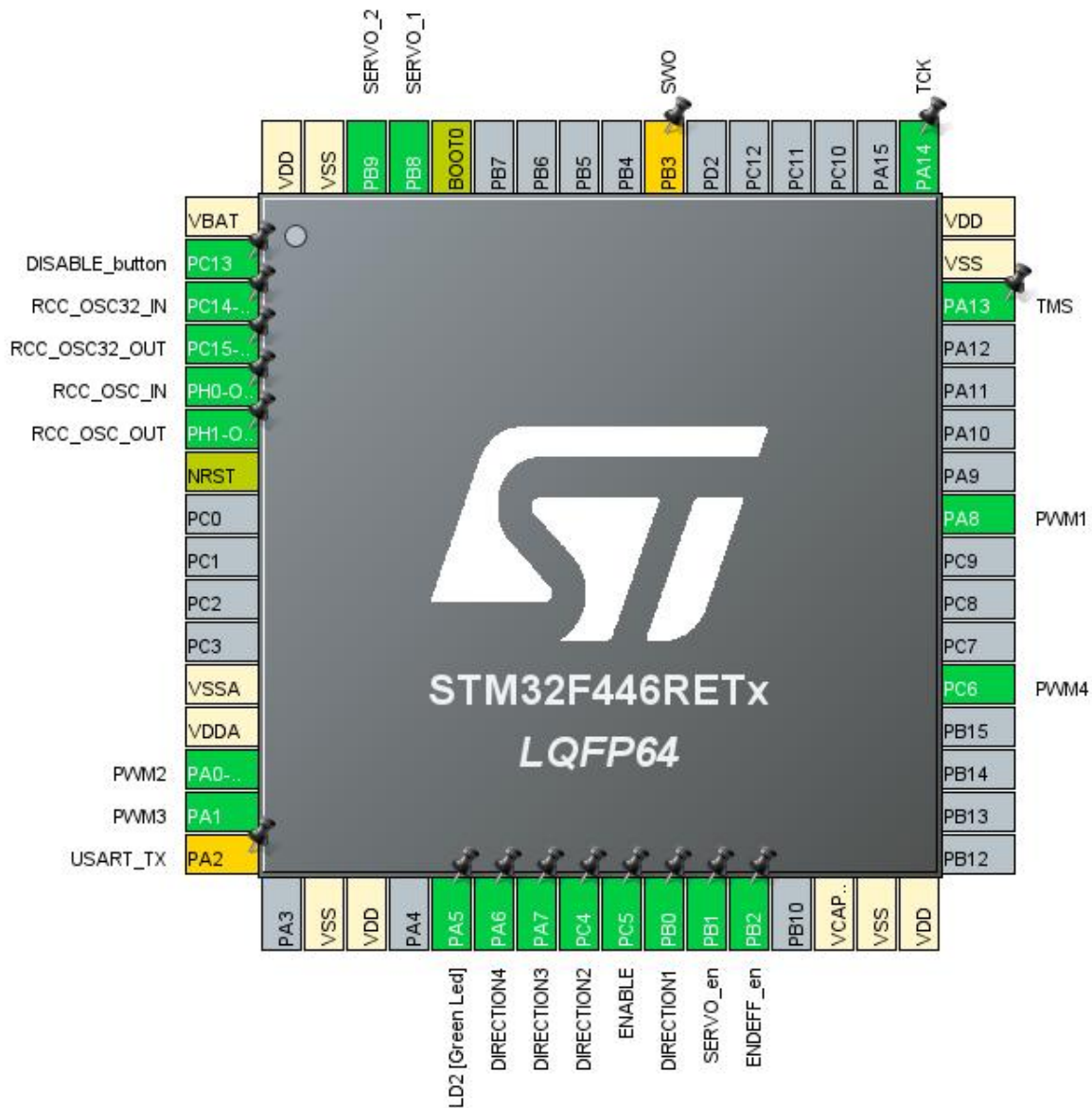
1.2. MCU

| | |
|----------------|---------------|
| MCU Series | STM32F4 |
| MCU Line | STM32F446 |
| MCU name | STM32F446RETx |
| MCU Package | LQFP64 |
| MCU Pin number | 64 |

1.3. Core(s) information

| | |
|---------|---------------|
| Core(s) | Arm Cortex-M4 |
|---------|---------------|

2. Pinout Configuration



3. Pins Configuration

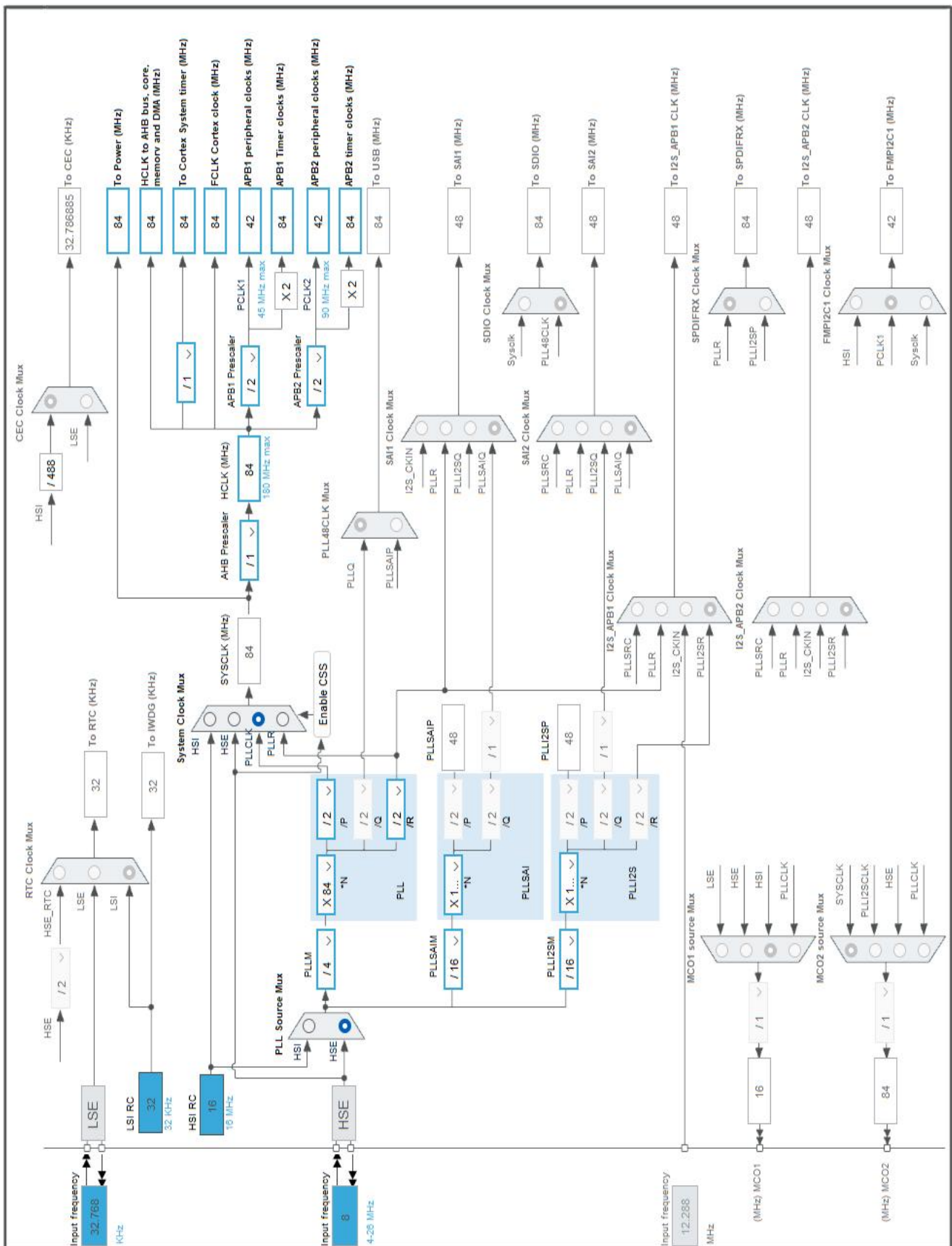
| Pin Number LQFP64 | Pin Name (function after reset) | Pin Type | Alternate Function(s) | Label |
|----------------------|---------------------------------------|----------|--------------------------|-----------------|
| 1 | VBAT | Power | | |
| 2 | PC13 | I/O | GPIO_EXTI13 | DISABLE_button |
| 3 | PC14-OSC32_IN | I/O | RCC_OSC32_IN | |
| 4 | PC15-OSC32_OUT | I/O | RCC_OSC32_OUT | |
| 5 | PH0-OSC_IN | I/O | RCC_OSC_IN | |
| 6 | PH1-OSC_OUT | I/O | RCC_OSC_OUT | |
| 7 | NRST | Reset | | |
| 12 | VSSA | Power | | |
| 13 | VDDA | Power | | |
| 14 | PA0-WKUP | I/O | TIM2_CH1 | PWM2 |
| 15 | PA1 | I/O | TIM2_CH2 | PWM3 |
| 16 | PA2 * | I/O | USART2_TX | USART_TX |
| 18 | VSS | Power | | |
| 19 | VDD | Power | | |
| 21 | PA5 ** | I/O | GPIO_Output | LD2 [Green Led] |
| 22 | PA6 ** | I/O | GPIO_Output | DIRECTION4 |
| 23 | PA7 ** | I/O | GPIO_Output | DIRECTION3 |
| 24 | PC4 ** | I/O | GPIO_Output | DIRECTION2 |
| 25 | PC5 ** | I/O | GPIO_Output | ENABLE |
| 26 | PB0 ** | I/O | GPIO_Output | DIRECTION1 |
| 27 | PB1 ** | I/O | GPIO_Output | SERVO_en |
| 28 | PB2 ** | I/O | GPIO_Output | ENDEFF_en |
| 30 | VCAP_1 | Power | | |
| 31 | VSS | Power | | |
| 32 | VDD | Power | | |
| 37 | PC6 | I/O | TIM8_CH1 | PWM4 |
| 41 | PA8 | I/O | TIM1_CH1 | PWM1 |
| 46 | PA13 | I/O | SYS_JTMS-SWDIO | TMS |
| 47 | VSS | Power | | |
| 48 | VDD | Power | | |
| 49 | PA14 | I/O | SYS_JTCK-SWCLK | TCK |
| 55 | PB3 * | I/O | SYS_JTDO-SWO | SWO |
| 60 | BOOT0 | Boot | | |
| 61 | PB8 | I/O | TIM10_CH1 | SERVO_1 |
| 62 | PB9 | I/O | TIM11_CH1 | SERVO_2 |
| 63 | VSS | Power | | |

| Pin Number LQFP64 | Pin Name (function after reset) | Pin Type | Alternate Function(s) | Label |
|----------------------|---------------------------------------|----------|--------------------------|-------|
| 64 | VDD | Power | | |

** The pin is affected with an I/O function

* The pin is affected with a peripheral function but no peripheral mode is activated

4. Clock Tree Configuration



1. Power Consumption Calculator report

1.1. Microcontroller Selection

| | |
|-----------|---------------|
| Series | STM32F4 |
| Line | STM32F446 |
| MCU | STM32F446RETx |
| Datasheet | DS10693_Rev6 |

1.2. Parameter Selection

| | |
|-------------|-----|
| Temperature | 25 |
| Vdd | 3.3 |

1.3. Battery Selection

| | |
|-------------------|-----------------|
| Battery | Li-SOCL2(A3400) |
| Capacity | 3400.0 mAh |
| Self Discharge | 0.08 %/month |
| Nominal Voltage | 3.6 V |
| Max Cont Current | 100.0 mA |
| Max Pulse Current | 200.0 mA |
| Cells in series | 1 |
| Cells in parallel | 1 |

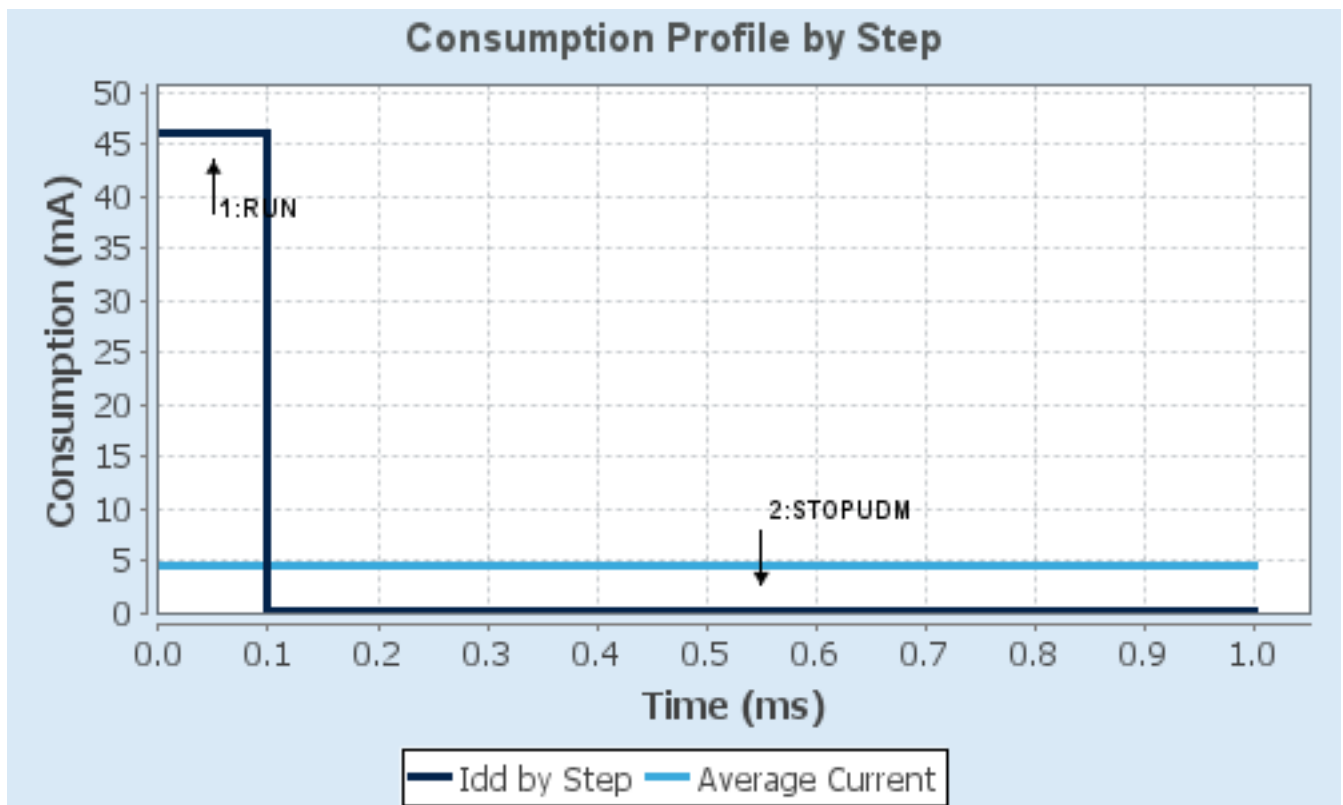
1.4. Sequence

| | | |
|-------------------------------|----------------------------------|---------------------------|
| Step | Step1 | Step2 |
| Mode | RUN | STOP UDM (Under Drive) |
| Vdd | 3.3 | 3.3 |
| Voltage Source | Battery | Battery |
| Range | Scale1-High | No Scale |
| Fetch Type | RAM/FLASH/REGON/ART/P REFETCH | n/a |
| CPU Frequency | 180 MHz | 0 Hz |
| Clock Configuration | HSE PLL | Regulator LP Flash-PwrDwn |
| Clock Source Frequency | 4 MHz | 0 Hz |
| Peripherals | | |
| Additional Cons. | 0 mA | 0 mA |
| Average Current | 46 mA | 55 μ A |
| Duration | 0.1 ms | 0.9 ms |
| DMIPS | 225.0 | 0.0 |
| Ta Max | 98.02 | 104.99 |
| Category | In DS Table | In DS Table |

1.5. Results

| | | | |
|---------------|---------|-----------------|-------------|
| Sequence Time | 1 ms | Average Current | 4.65 mA |
| Battery Life | 1 month | Average DMIPS | 225.0 DMIPS |

1.6. Chart



2. Software Project

2.1. Project Settings

| Name | Value |
|-----------------------------------|--|
| Project Name | robotic_arm |
| Project Folder | C:\Users\Francesco Stasi\OneDrive - Politecnico di |
| Toolchain / IDE | STM32CubeIDE |
| Firmware Package Name and Version | STM32Cube FW_F4 V1.28.1 |
| Application Structure | Advanced |
| Generate Under Root | Yes |
| Do not generate the main() | No |
| Minimum Heap Size | 0x200 |
| Minimum Stack Size | 0x400 |

2.2. Code Generation Settings

| Name | Value |
|---|---------------------------------------|
| STM32Cube MCU packages and embedded software | Copy only the necessary library files |
| Generate peripheral initialization as a pair of '.c/.h' files | Yes |
| Backup previously generated files when re-generating | No |
| Keep User Code when re-generating | Yes |
| Delete previously generated files when not re-generated | Yes |
| Set all free pins as analog (to optimize the power consumption) | No |
| Enable Full Assert | No |

2.3. Advanced Settings - Generated Function Calls

| Rank | Function Name | Peripheral Instance Name |
|------|--------------------|--------------------------|
| 1 | SystemClock_Config | RCC |
| 2 | MX_GPIO_Init | GPIO |
| 3 | MX_TIM3_Init | TIM3 |
| 4 | MX_TIM5_Init | TIM5 |
| 5 | MX_TIM1_Init | TIM1 |
| 6 | MX_TIM2_Init | TIM2 |
| 7 | MX_TIM4_Init | TIM4 |
| 8 | MX_TIM8_Init | TIM8 |
| 9 | MX_TIM10_Init | TIM10 |
| 10 | MX_TIM11_Init | TIM11 |
| 11 | MX_TIM6_Init | TIM6 |

3. Peripherals and Middlewares Configuration

3.1. RCC

High Speed Clock (HSE): Crystal/Ceramic Resonator

Low Speed Clock (LSE) : Crystal/Ceramic Resonator

3.1.1. Parameter Settings:

System Parameters:

| | |
|-------------------|--------------------|
| VDD voltage (V) | 3.3 |
| Instruction Cache | Enabled |
| Prefetch Buffer | Enabled |
| Data Cache | Enabled |
| Flash Latency(WS) | 2 WS (3 CPU cycle) |

RCC Parameters:

| | |
|--------------------------------|----------|
| HSI Calibration Value | 16 |
| TIM Prescaler Selection | Disabled |
| HSE Startup Timeout Value (ms) | 100 |
| LSE Startup Timeout Value (ms) | 5000 |

Power Parameters:

| | |
|-------------------------------|---------------------------------|
| Power Regulator Voltage Scale | Power Regulator Voltage Scale 3 |
| Power Over Drive | Disabled |

3.2. SYS

Debug: Serial Wire

Timebase Source: SysTick

3.3. TIM1

Clock Source : Internal Clock

Channel1: PWM Generation CH1

3.3.1. Parameter Settings:

Counter Settings:

| | |
|---|-----------------|
| Prescaler (PSC - 16 bits value) | 4 * |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 16 bits value) | 65535 |
| Internal Clock Division (CKD) | No Division |
| Repetition Counter (RCR - 8 bits value) | 0 |
| auto-reload preload | Enable * |

Trigger Output (TRGO) Parameters:

| | |
|-----------------------------|--|
| Master/Slave Mode (MSM bit) | Enable (Trigger delayed for master/slaves simultaneous start) * |
| Trigger Event Selection | Update Event * |

Break And Dead Time management - BRK Configuration:

| | |
|--------------|---------|
| BRK State | Disable |
| BRK Polarity | High |

Break And Dead Time management - Output Configuration:

| | |
|--|---------|
| Automatic Output State | Disable |
| Off State Selection for Run Mode (OSSR) | Disable |
| Off State Selection for Idle Mode (OSSI) | Disable |
| Lock Configuration | Off |

PWM Generation Channel 1:

| | |
|------------------------|------------|
| Mode | PWM mode 1 |
| Pulse (16 bits value) | 32768 * |
| Output compare preload | Enable |
| Fast Mode | Enable * |
| CH Polarity | High |
| CH Idle State | Reset |

3.4. TIM2

Clock Source : Internal Clock

Channel1: PWM Generation CH1

Channel2: PWM Generation CH2

3.4.1. Parameter Settings:

Counter Settings:

| | |
|---|-------------|
| Prescaler (PSC - 16 bits value) | 4 * |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 32 bits value) | 65535 * |
| Internal Clock Division (CKD) | No Division |
| auto-reload preload | Enable * |

Trigger Output (TRGO) Parameters:

| | |
|-----------------------------|--|
| Master/Slave Mode (MSM bit) | Enable (Trigger delayed for master/slaves simultaneous start) * |
| Trigger Event Selection | Update Event * |

PWM Generation Channel 1:

| | |
|----------------------------------|-----------------|
| Mode | PWM mode 1 |
| Pulse (32 bits value) | 32768 * |
| Output compare preload | Enable |
| Fast Mode | Enable * |
| CH Polarity | High |
| PWM Generation Channel 2: | |
| Mode | PWM mode 1 |
| Pulse (32 bits value) | 32768 * |
| Output compare preload | Enable |
| Fast Mode | Enable * |
| CH Polarity | High |

3.5. TIM3

Slave Mode: Trigger Mode

Trigger Source: ITR1

Clock Source : Internal Clock

3.5.1. Parameter Settings:

Counter Settings:

| | |
|---|-----------------|
| Prescaler (PSC - 16 bits value) | 65535 * |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 16 bits value) | 199 * |
| Internal Clock Division (CKD) | No Division |
| auto-reload preload | Enable * |
| Slave Mode Controller | Trigger Mode |

Trigger Output (TRGO) Parameters:

| | |
|-----------------------------|--|
| Master/Slave Mode (MSM bit) | Disable (Trigger input effect not delayed) |
| Trigger Event Selection | Reset (UG bit from TIMx_EGR) |

3.6. TIM4

Slave Mode: Trigger Mode

Trigger Source: ITR0

mode: Clock Source

3.6.1. Parameter Settings:

Counter Settings:

| | |
|---|--|
| Prescaler (PSC - 16 bits value) | 65535 * |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 16 bits value) | 199 * |
| Internal Clock Division (CKD) | No Division |
| auto-reload preload | Enable * |
| Slave Mode Controller | Trigger Mode |
| Trigger Output (TRGO) Parameters: | |
| Master/Slave Mode (MSM bit) | Disable (Trigger input effect not delayed) |
| Trigger Event Selection | Reset (UG bit from TIMx_EGR) |

3.7. TIM5

Slave Mode: Trigger Mode

Trigger Source: ITR3

mode: Clock Source

3.7.1. Parameter Settings:

| | |
|---|--|
| Counter Settings: | |
| Prescaler (PSC - 16 bits value) | 65535 * |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 32 bits value) | 199 * |
| Internal Clock Division (CKD) | No Division |
| auto-reload preload | Disable |
| Slave Mode Controller | Trigger Mode |
| Trigger Output (TRGO) Parameters: | |
| Master/Slave Mode (MSM bit) | Disable (Trigger input effect not delayed) |
| Trigger Event Selection | Reset (UG bit from TIMx_EGR) |

3.8. TIM6

mode: Activated

3.8.1. Parameter Settings:

| | |
|---|-----------------|
| Counter Settings: | |
| Prescaler (PSC - 16 bits value) | 1400*3 * |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 16 bits value) | 59999 * |
| auto-reload preload | Disable |

3.10. TIM10

mode: Activated

Channel1: PWM Generation CH1

3.10.1. Parameter Settings:

Counter Settings:

| | |
|---|-----------------|
| Prescaler (PSC - 16 bits value) | 0 |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 16 bits value) | 65535 |
| Internal Clock Division (CKD) | No Division |
| auto-reload preload | Enable * |

PWM Generation Channel 1:

| | |
|------------------------|-----------------|
| Mode | PWM mode 1 |
| Pulse (16 bits value) | 1 * |
| Output compare preload | Enable |
| Fast Mode | Enable * |
| CH Polarity | High |

3.11. TIM11

mode: Activated

Channel1: PWM Generation CH1

3.11.1. Parameter Settings:

Counter Settings:

| | |
|---|-----------------|
| Prescaler (PSC - 16 bits value) | 0 |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 16 bits value) | 65535 |
| Internal Clock Division (CKD) | No Division |
| auto-reload preload | Enable * |

PWM Generation Channel 1:

| | |
|------------------------|-----------------|
| Mode | PWM mode 1 |
| Pulse (16 bits value) | 1 * |
| Output compare preload | Enable |
| Fast Mode | Enable * |
| CH Polarity | High |

* User modified value

4. System Configuration

4.1. GPIO configuration

| IP | Pin | Signal | GPIO mode | GPIO pull/up pull down | Max Speed | User Label |
|-----------------------|----------------|----------------|--|-----------------------------|---------------|-----------------|
| RCC | PC14-OSC32_IN | RCC_OSC32_IN | n/a | n/a | n/a | |
| | PC15-OSC32_OUT | RCC_OSC32_OUT | n/a | n/a | n/a | |
| | PH0-OSC_IN | RCC_OSC_IN | n/a | n/a | n/a | |
| | PH1-OSC_OUT | RCC_OSC_OUT | n/a | n/a | n/a | |
| SYS | PA13 | SYS_JTMS-SWDIO | n/a | n/a | n/a | TMS |
| | PA14 | SYS_JTCK-SWCLK | n/a | n/a | n/a | TCK |
| TIM1 | PA8 | TIM1_CH1 | Alternate Function Push Pull | No pull-up and no pull-down | Low | PWM1 |
| TIM2 | PA0-WKUP | TIM2_CH1 | Alternate Function Push Pull | No pull-up and no pull-down | Low | PWM2 |
| | PA1 | TIM2_CH2 | Alternate Function Push Pull | No pull-up and no pull-down | Low | PWM3 |
| TIM8 | PC6 | TIM8_CH1 | Alternate Function Push Pull | No pull-up and no pull-down | Low | PWM4 |
| TIM10 | PB8 | TIM10_CH1 | Alternate Function Push Pull | No pull-up and no pull-down | Low | SERVO_1 |
| TIM11 | PB9 | TIM11_CH1 | Alternate Function Push Pull | No pull-up and no pull-down | Low | SERVO_2 |
| Single Mapped Signals | PA2 | USART2_TX | Alternate Function Push Pull | No pull-up and no pull-down | Very High * | USART_TX |
| | PB3 | SYS_JTDO-SWO | n/a | n/a | n/a | SWO |
| GPIO | PC13 | GPIO_EXTI13 | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a | DISABLE_button |
| | PA5 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | LD2 [Green Led] |
| | PA6 | GPIO_Output | Output Push Pull | Pull-down * | Low | DIRECTION4 |
| | PA7 | GPIO_Output | Output Push Pull | Pull-down * | Low | DIRECTION3 |
| | PC4 | GPIO_Output | Output Push Pull | Pull-down * | Low | DIRECTION2 |
| | PC5 | GPIO_Output | Output Push Pull | Pull-up * | High * | ENABLE |
| | PB0 | GPIO_Output | Output Push Pull | Pull-down * | Low | DIRECTION1 |
| | PB1 | GPIO_Output | Output Push Pull | Pull-down * | Low | SERVO_en |
| | PB2 | GPIO_Output | Output Push Pull | Pull-up * | Low | ENDEFF_en |

4.2. DMA configuration

nothing configured in DMA service

4.3. NVIC configuration

4.3.1. NVIC

| Interrupt Table | Enable | Preenmption Priority | SubPriority |
|--|--------|----------------------|-------------|
| Non maskable interrupt | true | 0 | 0 |
| Hard fault interrupt | true | 0 | 0 |
| Memory management fault | true | 0 | 0 |
| Pre-fetch fault, memory access fault | true | 0 | 0 |
| Undefined instruction or illegal state | true | 0 | 0 |
| System service call via SWI instruction | true | 0 | 0 |
| Debug monitor | true | 0 | 0 |
| Pendable request for system service | true | 0 | 0 |
| System tick timer | true | 0 | 0 |
| TIM1 trigger and commutation interrupts and TIM11 global interrupt | true | 1 | 0 |
| TIM1 capture compare interrupt | true | 1 | 0 |
| TIM2 global interrupt | true | 1 | 0 |
| EXTI line[15:10] interrupts | true | 0 | 0 |
| TIM8 break interrupt and TIM12 global interrupt | true | 1 | 0 |
| TIM8 update interrupt and TIM13 global interrupt | true | 1 | 0 |
| TIM8 trigger and commutation interrupts and TIM14 global interrupt | true | 1 | 0 |
| TIM8 capture compare interrupt | true | 1 | 0 |
| TIM6 global interrupt and DAC1, DAC2 underrun error interrupts | true | 1 | 0 |
| PVD interrupt through EXTI line 16 | unused | | |
| Flash global interrupt | unused | | |
| RCC global interrupt | unused | | |
| TIM1 break interrupt and TIM9 global interrupt | unused | | |
| TIM1 update interrupt and TIM10 global interrupt | unused | | |
| TIM3 global interrupt | unused | | |
| TIM4 global interrupt | unused | | |
| TIM5 global interrupt | unused | | |
| FPU global interrupt | unused | | |

4.3.2. NVIC Code generation

| Enabled interrupt Table | Select for init sequence ordering | Generate IRQ handler | Call HAL handler |
|-------------------------|-----------------------------------|----------------------|------------------|
| Non maskable interrupt | false | true | false |
| Hard fault interrupt | false | true | false |

| Enabled interrupt Table | Select for init sequence ordering | Generate IRQ handler | Call HAL handler |
|---|--------------------------------------|-------------------------|------------------|
| Memory management fault | false | true | false |
| Pre-fetch fault, memory access fault | false | true | false |
| Undefined instruction or illegal state | false | true | false |
| System service call via SWI instruction | false | true | false |
| Debug monitor | false | true | false |
| Pendable request for system service | false | true | false |
| System tick timer | false | true | true |
| TIM1 trigger and commutation interrupts and TIM11 global interrupt | false | true | true |
| TIM1 capture compare interrupt | false | true | true |
| TIM2 global interrupt | false | true | true |
| EXTI line[15:10] interrupts | false | true | true |
| TIM8 break interrupt and TIM12 global interrupt | false | true | true |
| TIM8 update interrupt and TIM13 global interrupt | false | true | true |
| TIM8 trigger and commutation interrupts and TIM14 global interrupt | false | true | true |
| TIM8 capture compare interrupt | false | true | true |
| TIM6 global interrupt and DAC1, DAC2 underrun error interrupts | false | true | true |

* User modified value

5. System Views

5.1. Category view

5.1.1. *Current*

6. Docs & Resources

| Type | Link |
|-------------------------|---|
| BSDL files | https://www.st.com/resource/en/bsdl_model/stm32f446_bsd.zip |
| IBIS models | https://www.st.com/resource/en/ibis_model/stm32f446_ibis.zip |
| System View Description | https://www.st.com/resource/en/svd/stm32f4-svd.zip |
| Presentations | https://www.st.com/resource/en/product_presentation/stm32-stm8_embedded_software_solutions.pdf |
| Presentations | https://www.st.com/resource/en/product_presentation/stm32_eval_tools_portfolio.pdf |
| Presentations | https://www.st.com/resource/en/product_presentation/stm32_stm8_functional-safety-packages.pdf |
| Presentations | https://www.st.com/resource/en/product_presentation/stm32-stm8_software_development_tools.pdf |
| Presentations | https://www.st.com/resource/en/product_presentation/microcontrollers-stm32-family-overview.pdf |
| Brochures | https://www.st.com/resource/en/brochure/products-and-solutions-for-plcs-and-smart-i-os.pdf |
| Flyers | https://www.st.com/resource/en/flyer/flstm32nucleo.pdf |
| Flyers | https://www.st.com/resource/en/flyer/flstm32trust.pdf |
| Product Certifications | https://www.st.com/resource/en/certification_document/stm32_authentication_can.pdf |
| Application Notes | https://www.st.com/resource/en/application_note/an1709-emc-design-guide-for-stm8-stm32-and-legacy-mcus-stmicroelectronics.pdf |
| Application Notes | https://www.st.com/resource/en/application_note/an2606-stm32-microcontroller-system-memory-boot-mode-stmicroelectronics.pdf |
| Application Notes | https://www.st.com/resource/en/application_note/an2945-stm8s-and-stm32-mcus-a-consistent-832bit-product-line-for-painless-migration-stmicroelectronics.pdf |
| Application Notes | https://www.st.com/resource/en/application_note/an3070-managing-the-driver-enable-signal-for-rs485-and-iolink-communications-with-the- |

stm32s-usart-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an3126-audio-and-waveform-generation-using-the-dac-in-stm32-products-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an3154-can-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an3155-usart-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an3156-usb-dfu-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an3364-migration-and-compatibility-guidelines-for-stm32-microcontroller-applications-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an3997-audio-playback-and-recording-using-the-stm32f4discovery-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an3998-pdm-audio-software-decoding-on-stm32-microcontrollers-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4031-using-the-stm32f2-stm32f4-and-stm32f7-series-dma-controller-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4221-i2c-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4286-spi-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4488-getting-started-with-stm32f4xxx-mcu-hardware-development-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4566-extending-the-dac-performance-of-stm32-microcontrollers-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4640-peripherals-interconnections-on-stm32f4057xx-stm32f4157xx-stm32f42xxx-stm32f43xxx-stm32f446xx-and-stm32f469479xx-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4655-virtually-increasing-the-number-of-serial-communication-peripherals-in-stm32-

applications-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4658-migration-of-applications-from-stm32f429439-lines-to-stm32f446-line-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4739-stm32cube-firmware-examples-for-stm32f4-series-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4750-handling-of-soft-errors-in-stm32-applications-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4776-generalpurpose-timer-cookbook-for-stm32-microcontrollers-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4803-highspeed-si-simulations-using-ibis-and-boardlevel-simulations-using-hyperlynx-si-on-stm32-mcus-and-mpus-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4850-stm32-mcus-spreadspectrum-clock-generation-principles-properties-and-implementation-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4989-stm32-microcontroller-debug-toolbox-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4995-using-an-electromyogram-technique-to-detect-muscle-activity-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an5027-interfacing-pdm-digital-microphones-using-stm32-mcus-and-mpus-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an5073-receiving-spdif-audio-stream-with-the-stm32f4f7h7-series-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4760-quadspi-interface-on-stm32-microcontrollers-and-microprocessors-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4899-stm32-microcontroller-gpio-hardware-settings-and-lowpower-consumption-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an5612-esd-protection-of-stm32-mcus-and-mpus-stmicroelectronics.pdf

- Application Notes https://www.st.com/resource/en/application_note/an4838-introduction-to-memory-protection-unit-management-on-stm32-mcus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an4879-introduction-to-usb-hardware-and-pcb-guidelines-using-stm32-mcus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5225-introduction-to-usb-typec-power-delivery-for-stm32-mcus-and-mpus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5537-how-to-use-adc-oversampling-techniques-to-improve-signal-to-noise-ratio-on-stm32-mcus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5036-guidelines-for-thermal-management-on-stm32-applications-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an4230-introduction-to-random-number-generation-validation-using-the-nist-statistical-test-suite-for-stm32-mcus-and-mpus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an2867-guidelines-for-oscillator-design-on-stm8afals-and-stm32-mcus-mpus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an4013-introduction-to-timers-for-stm32-mcus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an4277-how-to-use-pwm-shutdown-for-motor-control-and-digital-power-conversion-on-stm32-mcus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an4759-introduction-to-using-the-hardware-realtime-clock-rtc-and-the-tamper-management-unit-tamp-with-stm32-mcus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an4908-getting-started-with-uart-automatic-baud-rate-detection-for-stm32-mcus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5156-introduction-to-security-for-stm32-mcus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5543-guidelines-for-

enhanced-spi-communication-on-stm32-mcus-and-mpus-
stmicroelectronics.pdf

- Application Notes https://www.st.com/resource/en/application_note/an5992-migrating-from-stm32f446-to-stm32h523533-mcus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/cd00211314-how-to-optimize-the-adc-accuracy-in-the-stm32-mcus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an2639-soldering-recommendations-and-package-information-for-leadfree-ecopack2-mcus-and-mpus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5020-introduction-to-digital-camera-interface-dcml-for-stm32-mcus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an2656-stm32f10xxx-lcd-glass-driver-firmware-stmicroelectronics.pdf
for related Tools
& Software
- Application Notes https://www.st.com/resource/en/application_note/an2790-tft-lcd-interfacing-with-the-highdensity-stm32f10xxx-fsmc-stmicroelectronics.pdf
for related Tools
& Software
- Application Notes https://www.st.com/resource/en/application_note/an3078-stm32-inapplication-programming-over-the-ic-bus-stmicroelectronics.pdf
for related Tools
& Software
- Application Notes https://www.st.com/resource/en/application_note/an3116-stm32s-adc-modes-and-their-applications-stmicroelectronics.pdf
for related Tools
& Software
- Application Notes https://www.st.com/resource/en/application_note/an3174-implementing-receivers-for-infrared-remote-control-protocols-using-stm32f10xxx-microcontrollers-stmicroelectronics.pdf
for related Tools
& Software
- Application Notes https://www.st.com/resource/en/application_note/an3241-qvga-tftlcd-direct-drive-using-the-stm32f10xx-fsmc-peripheral-stmicroelectronics.pdf
for related Tools
& Software
- Application Notes https://www.st.com/resource/en/application_note/an3307-guidelines-for-obtaining-iec-60335-class-b-certification-for-any-stm32-application-stmicroelectronics.pdf
for related Tools
& Software
- Application Notes https://www.st.com/resource/en/application_note/an3965-stm32f40xstm32f41x-inapplication-programming-using-the-usart-
for related Tools

| | |
|--|---|
| & Software | stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an3969-EEPROM-emulation-in-stm32f40xstm32f41x-microcontrollers-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4044-floating-point-unit-demonstration-on-stm32-microcontrollers-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4323-getting-started-with-stemwin-library-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4365-using-stm32f4-mcu-power-modes-with-best-dynamic-efficiency-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4435-guidelines-for-obtaining-ulcsaiec-607301603351-class-b-certification-in-any-stm32-application-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4457-implementing-an-emulated-UART-on-stm32f4-microcontrollers-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4499-stm32-nrf51822-bluetooth-low-energy-system-solution-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4657-stm32-in-application-programming-IAP-using-the-USART-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4666-parallel-synchronous-transmission-using-GPIO-and-DMA-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4678-full-duplex-SPI-emulation-for-stm32f4-microcontrollers-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4701-proprietary-code-readout-protection-on-microcontrollers-of-the-stm32f4-series-stmicroelectronics.pdf |

| | |
|--|---|
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4739-stm32cube-firmware-examples-for-stm32f4-series-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4758-proprietary-code-readout-protection-on-stm32l4-stm32l4-stm32g4-and-stm32wb-series-mcus-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4841-digital-signal-processing-for-stm32-microcontrollers-using-cmsis-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4852-programming-an-external-flash-memory-using-the-uart-bootloader-builtin-stm32-microcontrollers-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4968-proprietary-code-read-out-protection-pcrop-on-stm32f72xxx-and-stm32f73xxx-microcontrollers-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an5056-integration-guide-for-the-xcubesbsfu-stm32cube-expansion-package-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an5360-getting-started-with-projects-based-on-the-stm32mp1-series-in-stm32cubeide-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an5361-getting-started-with-projects-based-on-dualcore-stm32h7-microcontrollers-in-stm32cubeide-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an5394-getting-started-with-projects-based-on-the-stm32l5-series-in-stm32cubeide-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an5418-how-to-build-a-simple-usbp-d-sink-application-with-stm32cubemx-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an5426-migrating-graphics-middleware-projects-from-stm32cubemx-540-to-stm32cubemx-550-stmicroelectronics.pdf |
| Application Notes | https://www.st.com/resource/en/application_note/an5464-position-control- |

| | |
|--|---|
| for related Tools & Software | of-a-threephase-permanent-magnet-motor-using-xcubemcsdk-or-xcubemcsdkful-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an5564-getting-started-with-projects-based-on-dualcore-stm32wl-microcontrollers-in-stm32cubeide-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an5698-adapting-the-xcubestl-functional-safety-package-for-stm32-iec-61508-compliant-to-other-safety-standards-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an5731-stm32cubemx-and-stm32cubeide-threadsafe-solution-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4502-stm32-smbuspmbus-expansion-package-for-stm32cube-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an5952-how-to-use-cmake-in-stm32cubeide-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an5054-how-to-perform-secure-programming-using-stm32cubeprogrammer-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an6179-how-to-integrate-the-stl-firmware-into-a-time-critical-user-application-stmicroelectronics.pdf |
| Errata Sheets | https://www.st.com/resource/en/errata_sheet/es0298-stm32f446xcxe-device-errata-stmicroelectronics.pdf |
| Datasheet | https://www.st.com/resource/en/datasheet/dm00141306.pdf |
| Programming Manuals | https://www.st.com/resource/en/programming_manual/pm0214-stm32-cortexm4-mcus-and-mpus-programming-manual-stmicroelectronics.pdf |
| Reference Manuals | https://www.st.com/resource/en/reference_manual/rm0390-stm32f446xx-advanced-armbased-32bit-mcus-stmicroelectronics.pdf |
| Technical Notes & Articles | https://www.st.com/resource/en/technical_note/tn0516-overview-of-the-stm32f0xf100xxf103xx-and-stm32f2xxf30xf4xx-mcus-pmsm-singledual-foc-sdk-v40-stmicroelectronics.pdf |

| | |
|-------------------------------|---|
| Technical Notes & Articles | https://www.st.com/resource/en/technical_note/tn1163-description-of-wlcsp-for-microcontrollers-and-recommendations-for-its-use-stmicroelectronics.pdf |
| Technical Notes & Articles | https://www.st.com/resource/en/technical_note/tn1204-tape-and-reel-shipping-media-for-stm32-microcontrollers-in-bga-packages-stmicroelectronics.pdf |
| Technical Notes & Articles | https://www.st.com/resource/en/technical_note/tn1205-tape-and-reel-shipping-media-for-stm8-and-stm32-microcontrollers-in-fpn-packages-stmicroelectronics.pdf |
| Technical Notes & Articles | https://www.st.com/resource/en/technical_note/tn1206-tape-and-reel-shipping-media-for-stm8-and-stm32-microcontrollers-in-qfp-packages-stmicroelectronics.pdf |
| Technical Notes & Articles | https://www.st.com/resource/en/technical_note/tn1207-tape-and-reel-shipping-media-for-stm8-and-stm32-microcontrollers-in-so-packages-stmicroelectronics.pdf |
| Technical Notes & Articles | https://www.st.com/resource/en/technical_note/tn1208-tape-and-reel-shipping-media-for-stm8-and-stm32-microcontrollers-in-tssop-and-ssop-packages-stmicroelectronics.pdf |
| Technical Notes & Articles | https://www.st.com/resource/en/technical_note/tn1433-reference-device-marking-schematics-for-stm32-microcontrollers-and-microprocessors-stmicroelectronics.pdf |
| Technical Notes & Articles | https://www.st.com/resource/en/technical_note/tn1489-security-bulletin-tn1489stpsirt-physical-attacks-on-stm32-and-stm32cube-firmware-stmicroelectronics.pdf |