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# STM32G4 mainstream series mixed-signal MCU

STM32

# STM3G4 series, continuity of STM32F3


## MPU

**STM32MP1**
4158 CoreMark
Up to 800 MHz Cortex-A7
209 MHz Cortex-M4

## High Perf MCUs

| STM32F2 | STM32F4 | STM32F7 | STM32H7 |
|---|---|---|---|
| Up to 398 CoreMark | Up to 608 CoreMark | 1082 CoreMark | Up to 3224 CoreMark |
| 120 MHz Cortex-M3 | 180 MHz Cortex-M4 | 216 MHz Cortex-M7 | Up to 550 MHz Cortex -M7 |
| | | | 240 MHz Cortex -M4 |

## Mainstream MCUs

| STM32F0 | STM32G0 | STM32F1 | STM32F3 | STM32G4 |
|---|---|---|---|---|
| 106 CoreMark | 142 CoreMark | 177 CoreMark | 245 CoreMark | 569 CoreMark |
| 48 MHz Cortex-M0 | 64 MHz Cortex-M0+ | 72 MHz Cortex-M3 | 72 MHz Cortex-M4 | 170 MHz Cortex-M4 |

***Mixed-signal MCUs***

## Ultra-low Power MCUs

| STM32L0 | STM32L1 | STM32L4 | STM32L4+ | STM32L5 | STM32U5 |
|---|---|---|---|---|---|
| 75 CoreMark | 93 CoreMark | 273 CoreMark | 409 CoreMark | 443 CoreMark | 651 CoreMark |
| 32 MHz Cortex-M0+ | 32 MHz Cortex-M3 | 80 MHz Cortex-M4 | 120 MHz Cortex-M4 | 110 MHz Cortex-M33 | 160 MHz Cortex-M33 |

## Wireless MCUs

| STM32WL | STM32WB |
|---|---|
| 162 CoreMark | 216 CoreMark |
| 48 MHz Cortex-M4 | 64 MHz Cortex-M4 |
| 48 MHz Cortex-M0+ | 32 MHz Cortex-M0+ ● |

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Latest product generation ● Radio co-processor only

# STM32G4 series

**Ideal for applications requiring an MCU that offers advanced and rich analog peripherals**


- Control applications (Motor Control…)
- Industrial equipment
- Instrumentation and Measurement
- Digital Power
  - Digital SMPS (Switch Mode Power Supply)
  - PFC (Power Factor Correction)

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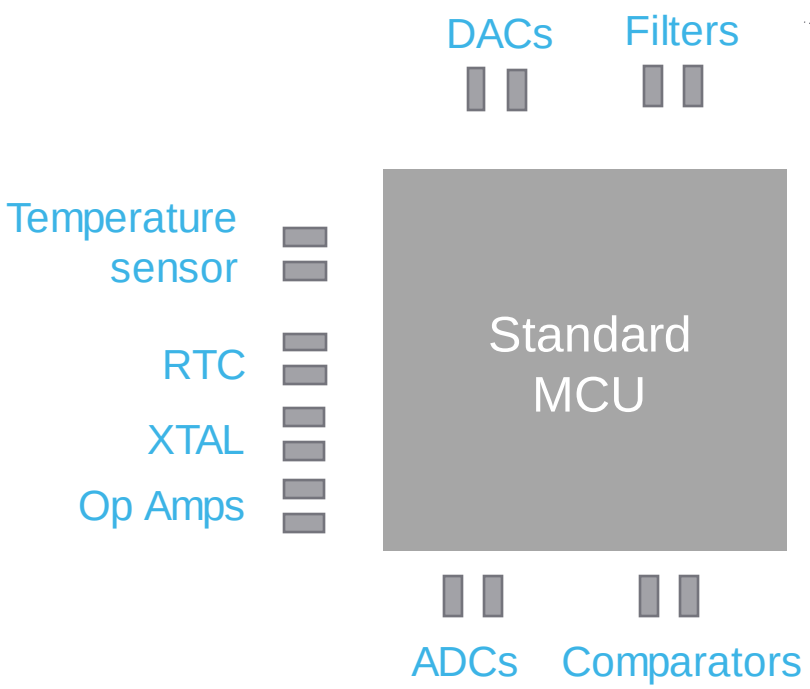
# Reducing PCB size and BOM cost

## System-on-Chip – All-in-one solution



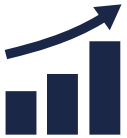

Project cost $$$

Smaller package
**Fewer additional** components
All analog included

**STM**32G4

Project cost $

# Measurement and control

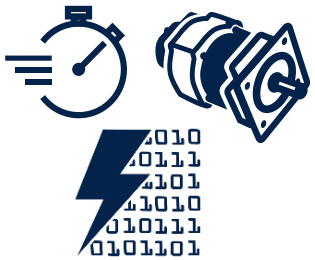


## High performance
ARM Cortex-M4 + FPU running @ 170Mhz
+ 3x Accelerators: ART, Routine Booster(CCM), Math. Accel

## 7x Comparators
Down to 19ns propagation delay

## 5x ADC
5x12-bit, 16-bit oversampling
4 MSPS (0.25µs)

## 7xDAC
12-bit DAC 15 Msps



## Motor control Timer & High-resolution Timer (D-Power)
12 channels up to 184 ps resolution


## USB Type-C Power Delivery

## High robustness
**Highly immune** to fast transients
**Robust IOs** against negative injections

## Security
Arm PSA Level 1 logical security certification


## Functional Safety
SIL and CLASSB Safety Packages, including Self-Test Library


## FD CAN
Up to 3 instances
Payload bit rate 8 times bigger than standard CAN

## High temperature
from -40°C
up to + **125°C**

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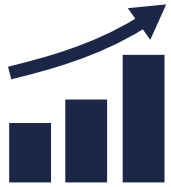
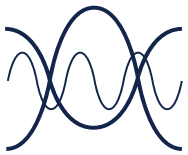
# STM32G4 series – key messages



## Performance

- Arm® Cortex®-M4 at 170 MHz
- 213 DMIPS and 569 CoreMark® results
- Better dynamic power consumption (163µA/MHz)

- ART **Accelerator**™ (dynamic cache)
- CCM-SRAM Routine **Booster** (static cache)
- Mathematical **Accelerators** (FMAC, CORDIC)



## Rich Integrated Analog and Digital

- Op-Amps (Built-in gain), DACs, Comparators
- 12-bit ADCs 4Msps with hardware oversampling
- CAN-FD (flexible data rate – 8 Msps bit rate)

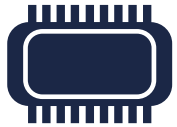
- High resolution timer (184 ps)
- USB type-C Power Delivery 3.0
- 1% RC accuracy [-5°..90°C], 2% full T° range

## Safety and security focus

- Dual Bank Flash with ECC (error code correction)
- Securable Memory Area
- Hardware encryption AES-256
- SIL, Class-B
- SRAM with Parity bit

Secure Live Upgrade

Functional safety design packages



## Complete portfolio

- Complements existing STM32F3 Series portfolio
- From -40°c up to 85 or 125°C devices

- From 32- up to 128-pin
- From 32 KB to 512 KB Flash

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# From F3 to G4 series, an improvement in continuity

STM32F3

## Increased Robustness, Safety and Security

- EMC (EMI, EMS) → continuous improvement
- **Dual Bank** Flash w/ ECC (Live FW Upgrade)
- HW encryption AES
- **Securable Memory Area**

## Gain in Performance

- **170MHz** even from internal oscill. (**213DMIPS**)
  1. ART accelerator (~dynamic cache)
  2. CCM-SRAM Routine Booster (~static cache)
  3. **Mathematical accelerator** (Trigo, Filtering)
- Better dynamic power conso (160µA/Mhz) = ~2.7 times lower than F3 series

## Extended Peripheral set and Architecture

- **1%** RC accuracy [-5°..90°C], 2% full range
- ADC with **HW oversampling = 16-bit** res.
- Renewed Op-Amp, DAC, Comparator
- New HR timer features (digital part)
- MC timer improvements (encoder mode…)
- USB type-C with Power Delivery incl. PHY
- CAN FD (Flexible Data-rate)
- Ta: 85° up to **125°C** (limited condition)

## STM32F3 portfolio extension

- D-Power portfolio (STM32F334) extension
- **NEW 128-pin** and **80-pin** packages (LQFP)

**STM32G4**

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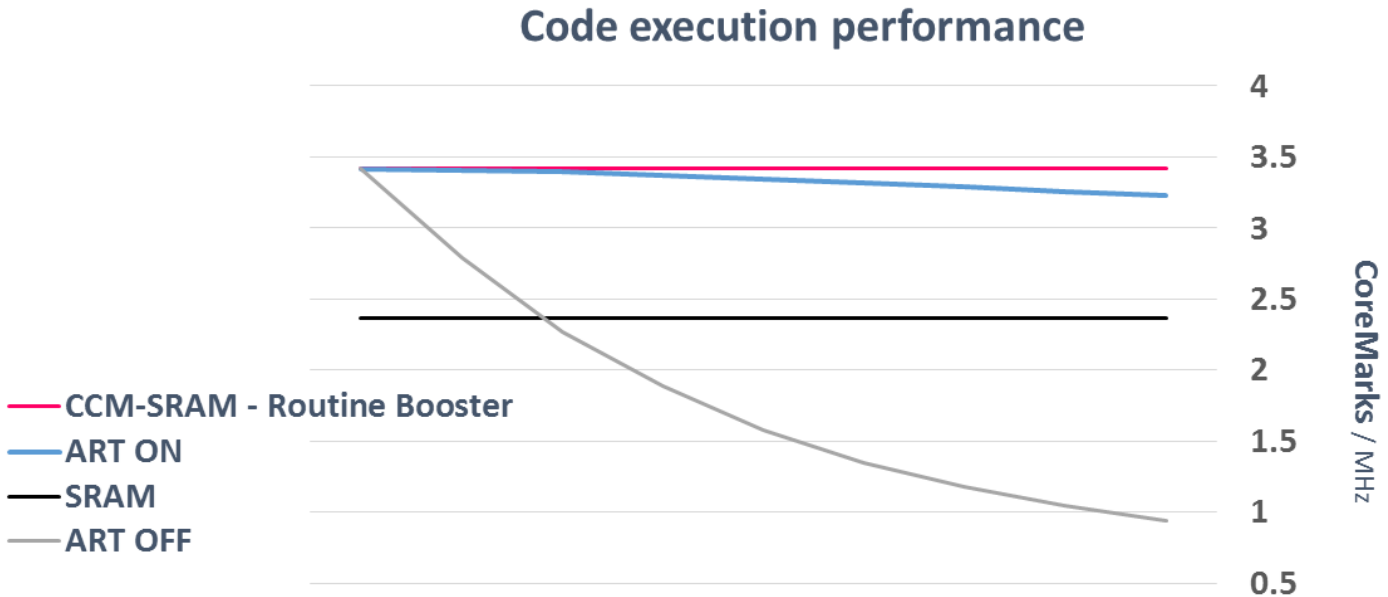
# Greater performance

## Pure 170 MHz CPU performance (Arm® Cortex®-M4) with three accelerators




| Number of Wait States | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| CPU Clock (MHz) | 34 | 68 | 102 | 136 | 170 |

Arm Cortex-M4 with **FPU**

**Up to 170** MHz CPU frequency

**Up to 213 DMIPS and 569 CoreMark®** results

**3** different **HW accelerators**:

- **ART accelerator** (~dynamic cache) → Full code acceleration (average)
- **Routine Booster** CCM-SRAM (~static cache) → determinism preserved
- **Mathematical** (Cordic + FMAC) NEW

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NEW

# Mathematical accelerators

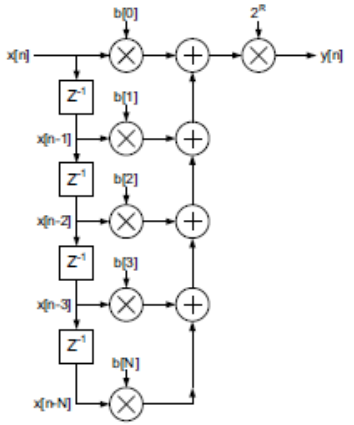
## Function acceleration and CPU offload

1. **Cordic (Trigo)**
   - Very helpful for Field Oriented Motor Control method (FOC)

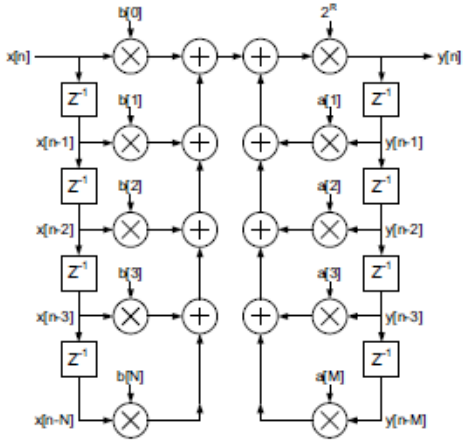
- Vector rotation (polar to rectangular): Sin, Cos
- Vector translation (rectangular to polar): Atan2, Modulus
- Sinh, Cosh, Exp
- Atan, Atanh
- Square root
- Ln

2. **Filter Math ACcelerator (FMAC)**
   - Can be used to create
     - 3p3z Compensator (→ Digital power)
     - Sigma Delta modulator
     - Noise Shaper

**FIR filter**



**IIR filter**



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# Rich, advanced analog

## Mixed-signal SoC for wide variety of applications

| ADC (up to 5) | Values |
|---|---|
| Topology | **SAR 12-bit**<br>+ HW oversampling → **16-bit** |
| Sampling rate | Up to **4 Msps** |
| Input | Single-ended and differential |
| Offset and Gain compensation | Auto calibration to reduce gain and offset |

| DAC (up to 7) | Values |
|---|---|
| Sampling rate | **15 Msps** (internal)<br>1 Msps (from buffered output) |
| Settling time | 16 ns |

| Op-Amp (up to 6) | Values |
|---|---|
| GBW | **13 MHz** |
| Slew rate | **45 V/µs** |
| Offset | 3 mV over full T° range<br>1.5 mV @ 25°C |
| PGA Gain (accuracy) | 2, 4, 8, 16, -1,-3,-7,-15 **(1%)**<br>32, 64, -31,-63 (2%) |

| Comparator (up to 7) | Values |
|---|---|
| Power supply | 1.62 .. 3.6 V |
| Propagation delay | **16.7 ns** |
| Offset | -6 .. +2 mV |
| Hysteresis | 8 steps:<br>0, 9, 18, 27, 36, 45, 54, 63 mV |

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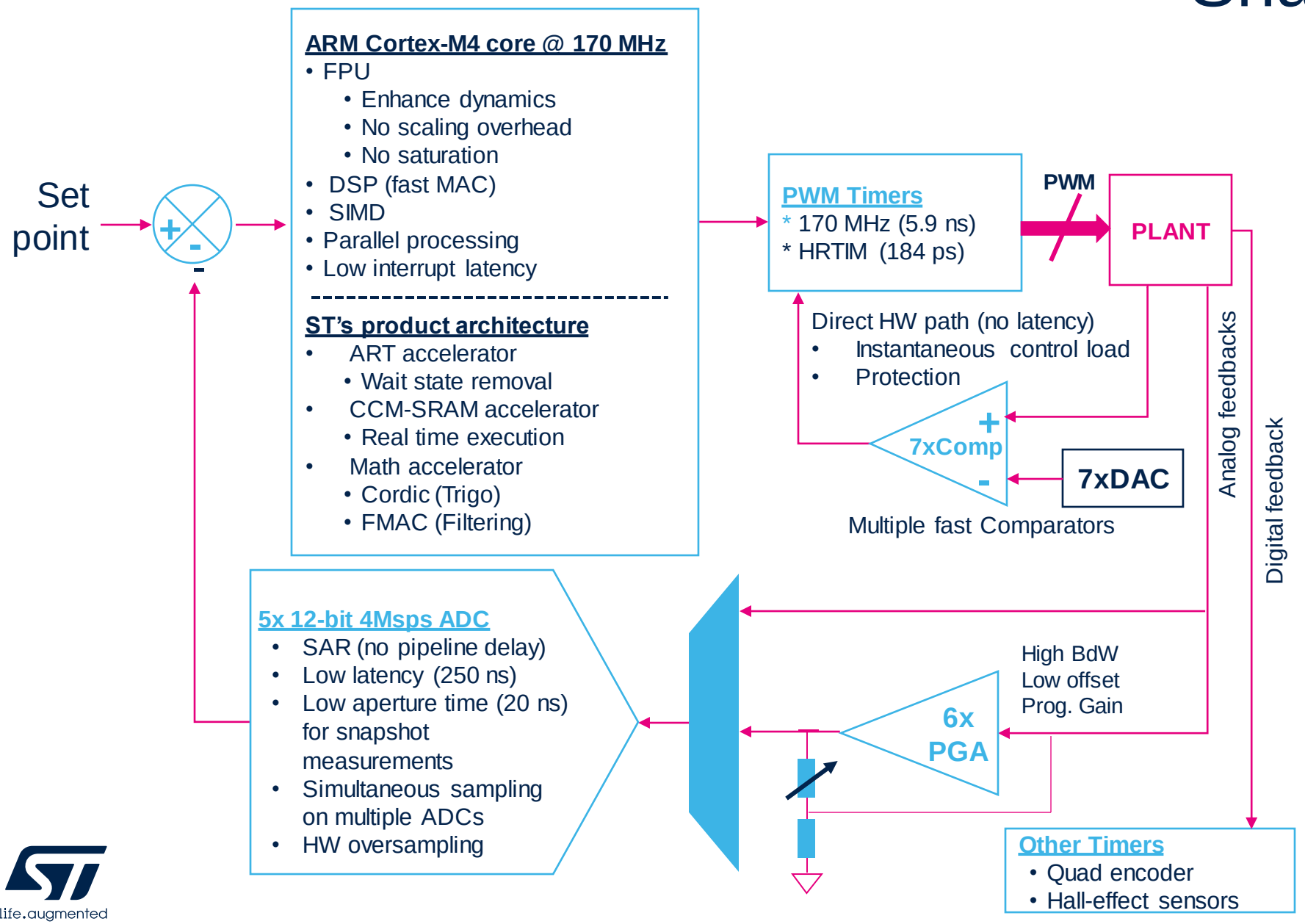
# Shaped for control




Easy use of the Analog and Digital resources thanks to high peripherals interconnect and flexible bus matrix

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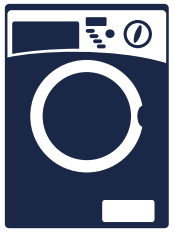
# Key features for targeted applications

## Motor Control

### Home appliances, E-bikes, Air Conditioning

- Fast CPU 170 MHz
- Mathematical accelerator (Cordic)
- Advanced Motor Control timers
- Fast comparators
- 4Msps ADC-12bit + HW oversampling
- Op-Amp with built-in gain (PGA)
- DAC-12bit
- 1% RC accuracy
  (UART communication w/o external Xtal)



## High-End Consumer

### Rechargeable devices, drones, toys

- Low-thickness, small form-factor
- Low consumption in run mode ~ 160 µA/MHz
- Embedded analog
- SAI (Sound Audio Interface)
- USB type-C Power Delivery 3.0

## Industrial devices Measurements

### Industrial equipment

- Fast CPU 170 MHz
- Mathematical accelerator (Cordic)
- High temperature 125°C
- CAN FD support
- SPI, USART, I²C
- Advanced timers
- Real Time Clock with backup registers
- Dual bank flash for live upgrade
- AES & security

## Digital Power

### Servers, Telecom, EV Charging station

- Fast CPU 170 MHz
- Mathematical accelerator (Filtering)
- 12ch High Resolution timer (184ps)
- 4Msps ADC-12bit + HW oversampling
- Fast comparators (17ns)
- Embedded analog
- Dual bank flash for **live** upgrade
- AES & security
- FMAC for 3p3z compensation

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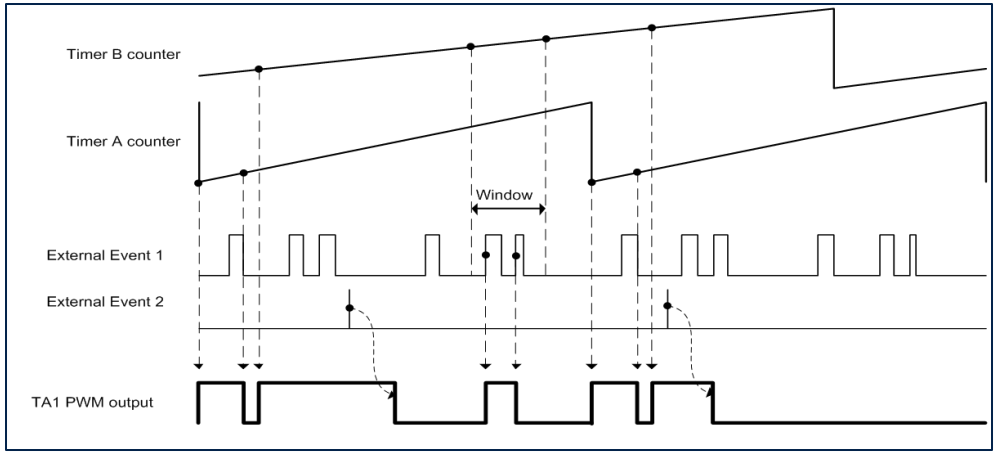
# Ease digital power conversion


Enhance your digital power solutions using the STM32G4 comprehensive **High Resolution Timer (HRTIM)**

# HRTimer – not only high resolution

## High resolution PWM

- 12 channels with 184ps resolution on frequency and duty cycle
- 184ps is equivalent to 5.4GHz timer clock




## Flexible PWM generation

- 7x independent time base to create various shape of PWM
- 6x complementary pair PWM outputs
- Up to 32 set/reset transition per PWM period thx to the built-in crossbar
- Master/Slave configuration for multi phase converter

## Multiple Event handler

- 6x Digital and Analog fault input
- 10x Events cycle to cycle current control or PWM restart (constant Ton/Toff)
- Blanking, windowing and digital filter

## 12 independent channels

- Any topology supported from 1x 12 PWM (triple interleaved LLC (servers' application) up to 12x1 PWM (multiple independent buck converters (lighting)

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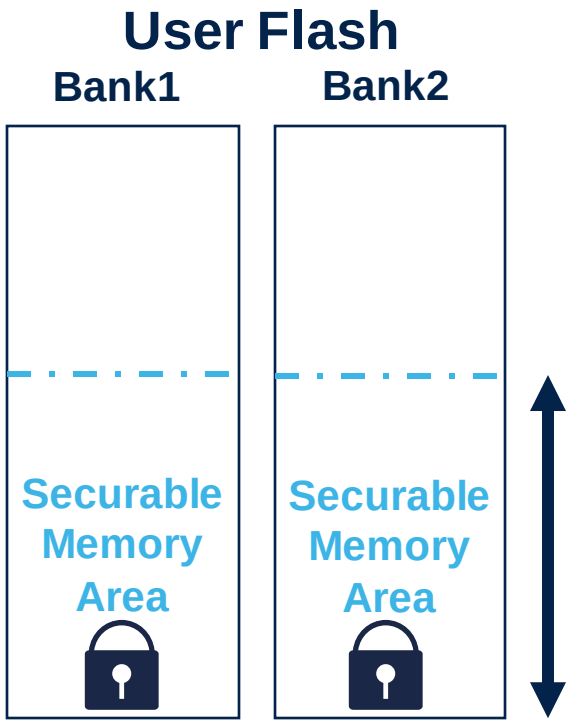
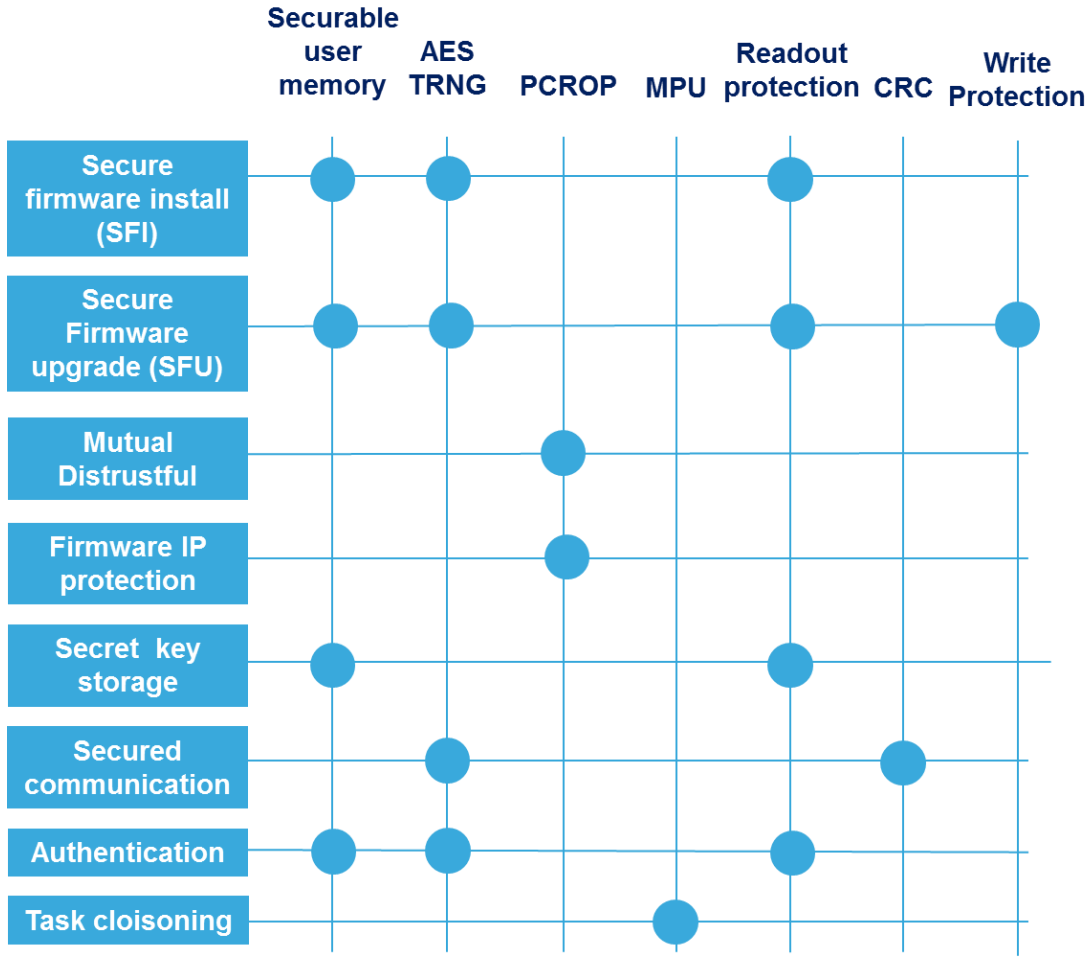
# Greater security

## Integrated security features, ready for tomorrow's needs




**Securable Memory Area:**

- Configurable size
- Can be secured once exiting
  - No more access nor debug possible
- Good fit to store critical data
  - Critical routines
  - Keys

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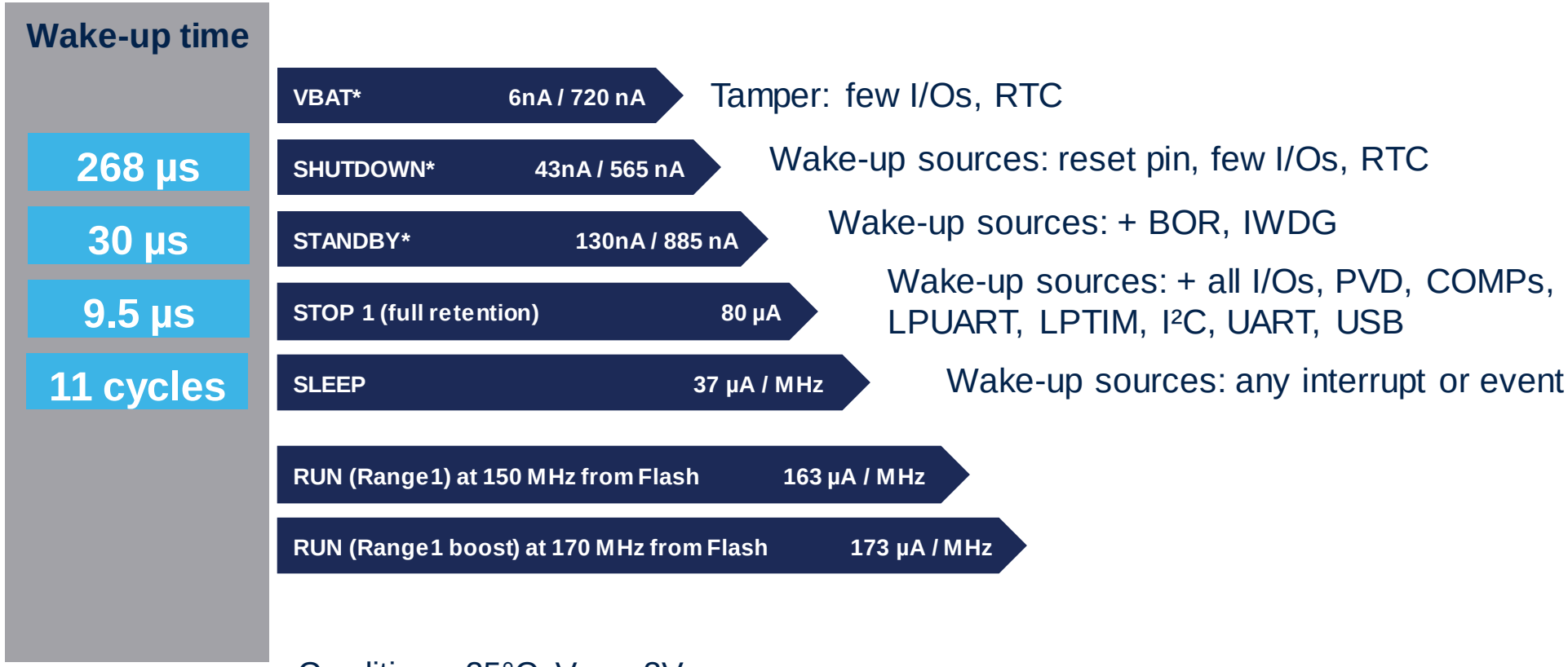
# Dynamic efficiency modes

## When Mainstream MCU Series meets low-power requirements




Conditions: 25°C, $V_{DD}$ = 3V

Note : * without RTC / with RTC

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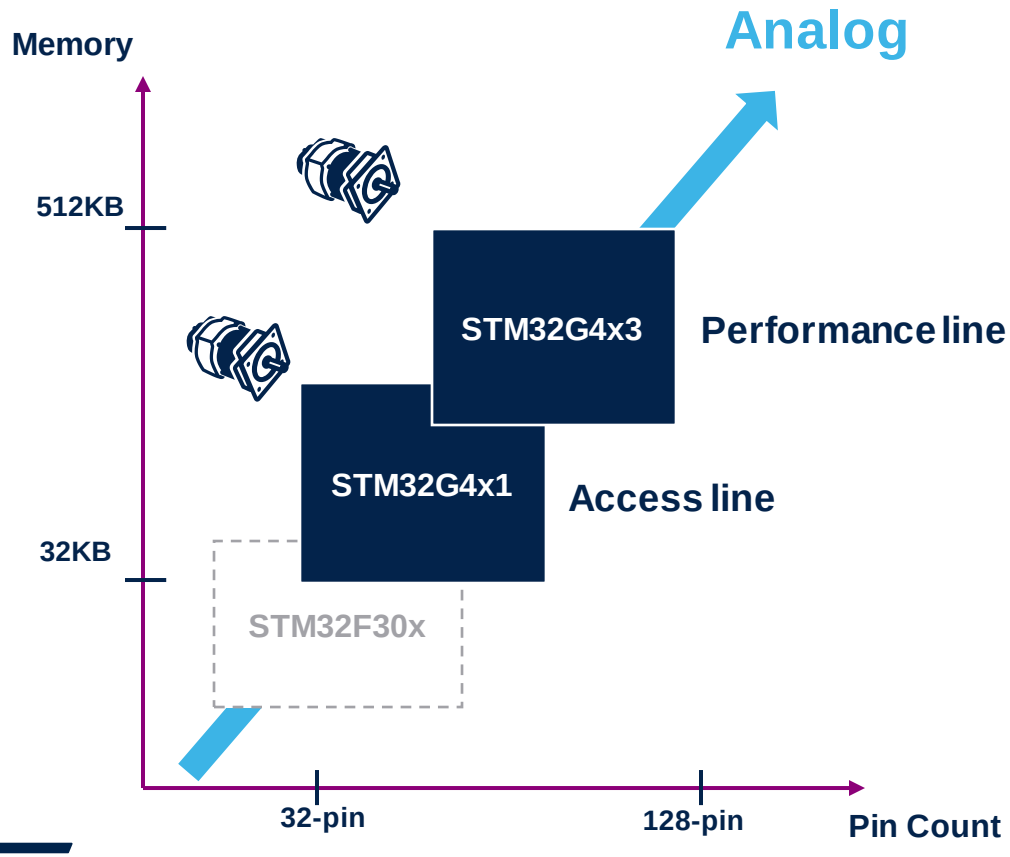
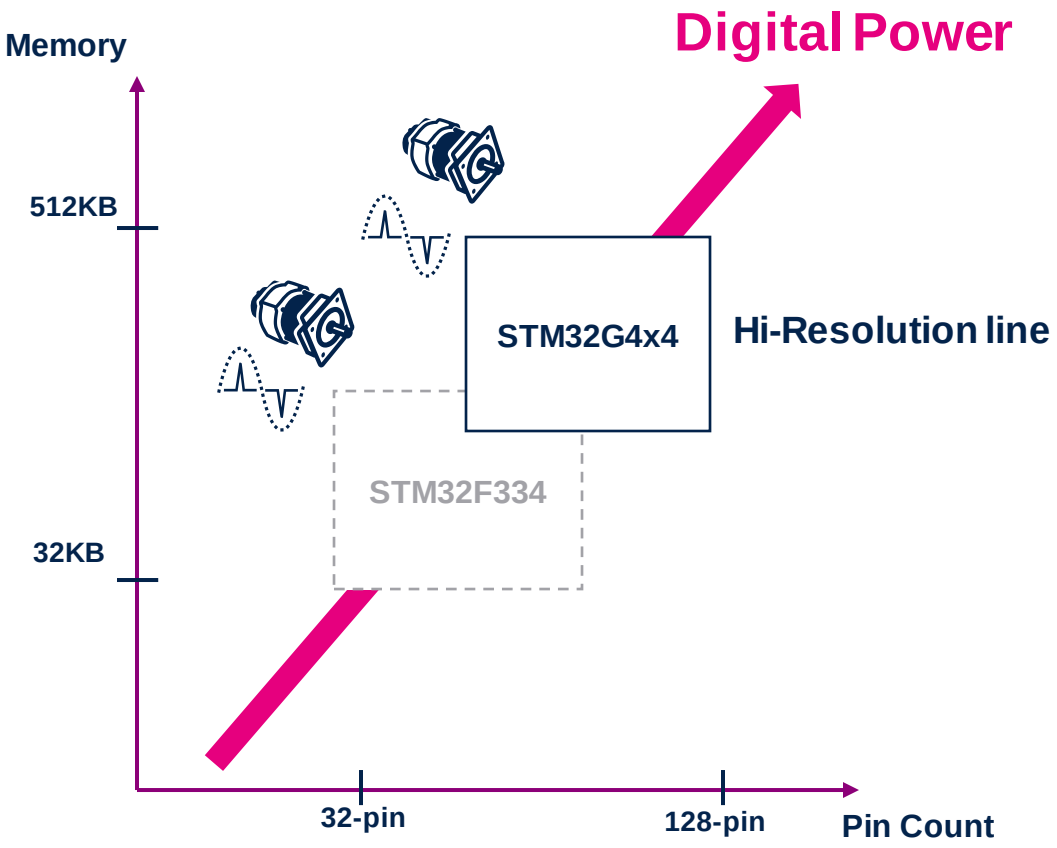
# STM32G4 products lines

## General Purpose




## Application Specific

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# Extensive & innovative peripheral set

## No compromise on what matters

| Unit parameters | STM32G474 Hi-Resolution line | STM32G473 Performance line | STM32G431 Access line | STM32G491 Access line |
|---|---|---|---|---|
| **Core, frequency** | ARM Cortex-M4, 170 MHz | | | ARM Cortex-M4, 170 MHz |
| **Flash (max)** | 512 Kbytes (2x256 KB dual bank) | | 128 Kbytes single bank | **512** Kbytes single bank |
| **RAM (up to)** | 96 Kbytes | | 22 Kbytes | 96 Kbytes |
| **CCM –SRAM (code-SRAM)** | 32 Kbytes | | 10 Kbytes | 16 Kbytes |
| **12-bit ADC SAR** | 5x 12-bit<br>4 MSPS | | 2x 12-bit<br>4 MSPS | 3x 12-bit<br>4 MSPS |
| **Comparator** | 7 | | 4 | **4** |
| **Op Amp with 4 built-in gain values with 1% accuracy** | 6 | | 3 | **4** |
| **12-bit DAC** | 7 | | 4 | **4** |
| **Motor Control timer** | 3x (170 MHz) | | 2x (170 MHz) | **3x** (170MHz) |
| **CAN-FD** | 3x | | 1x | **2x** |
| **12 channel Hi-resolution Timer** | 1x | - | - | - |
| **Power supply** | 1.72 to 3.6 V | | | 1.72 to 3.6 V |

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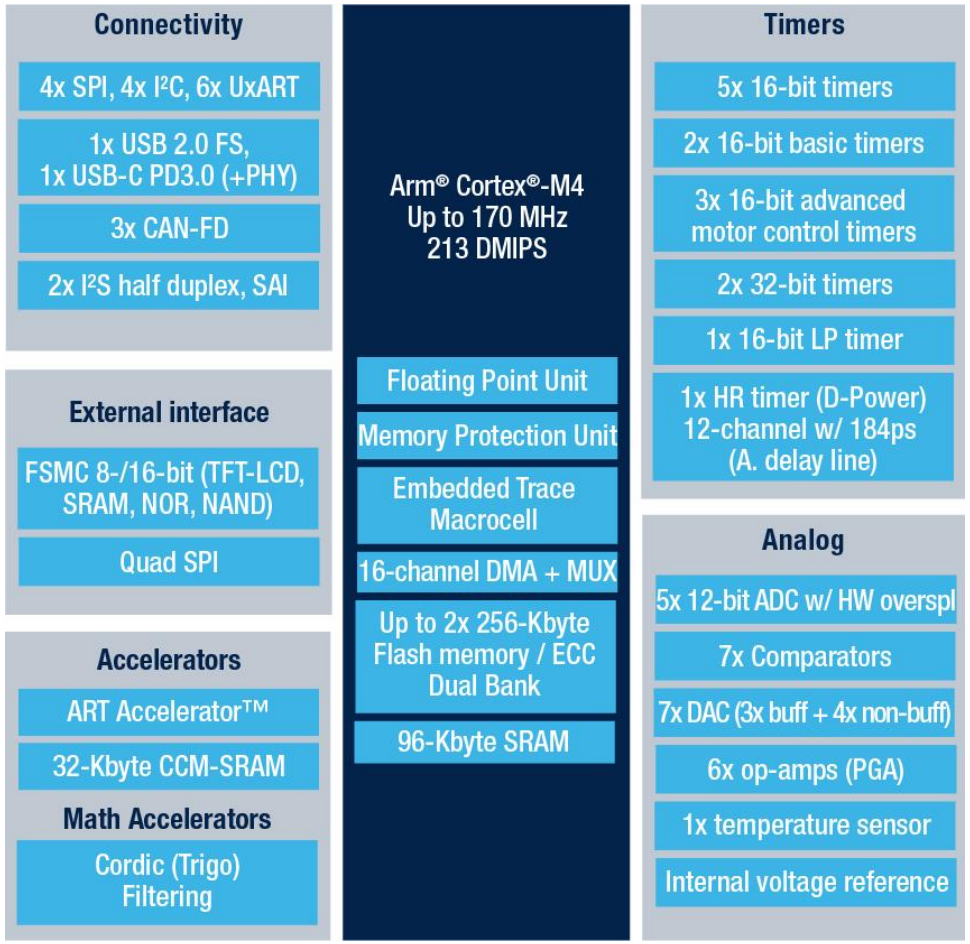
# STM32G474/3 block diagram

## High Resolution and Performance lines [128KB .. 512KB]

- 32-bit Arm Cortex-M4 core with FPU
- ART + CCM-SRAM + Mathematic Accelerators
- Dual Bank Flash with ECC
- SRAM with Parity bit
- +/- 1% internal clock
- 1.72 to 3.6V power supply
- Up to 125°C




- High resolution timer *(G474 only)*
- 3x Advanced Motor Control timers
- Rich Advanced Analog
- 3x CAN Flexible Data rate
- USB-C Power Delivery3.0
- Advanced Security and Safety features
- Robustness: highest level 5 / FTB/ESD - IEC 61000-4-4

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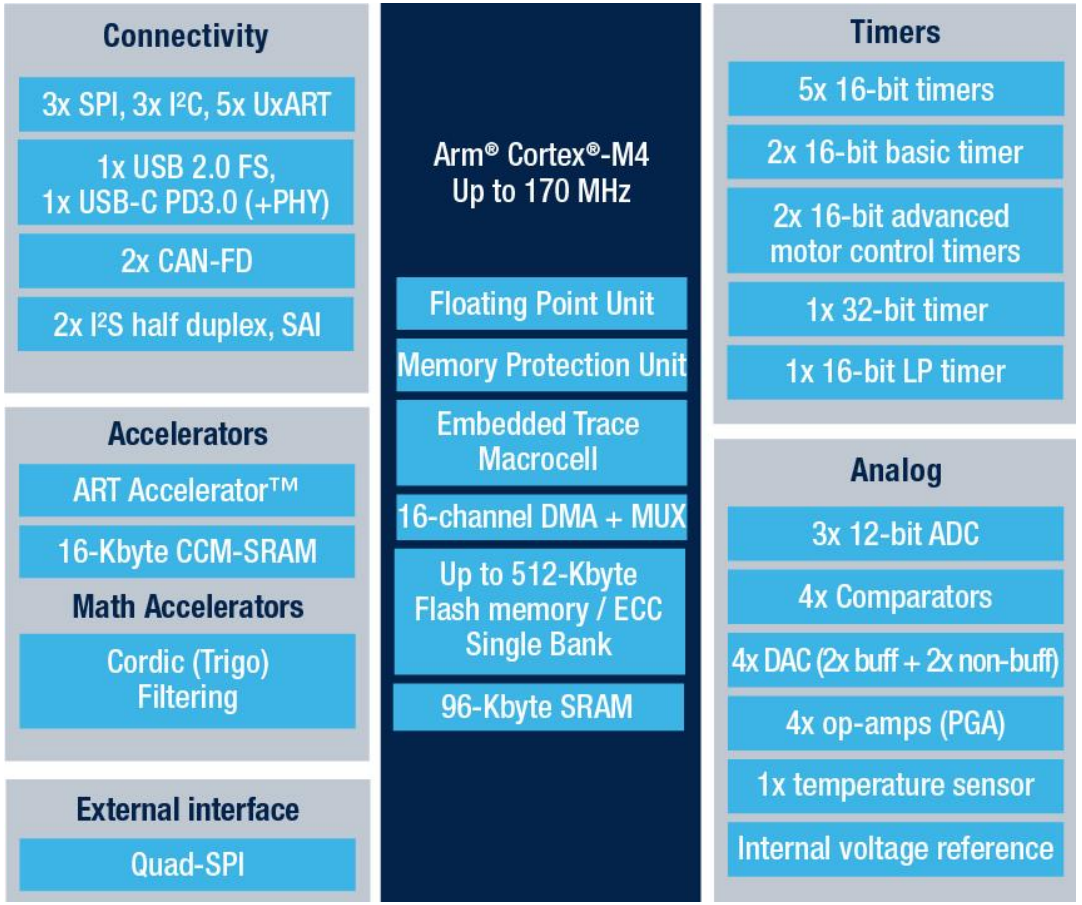
# STM32G491 block diagram

## Access line [32KB .. 512KB]

- 32-bit Arm Cortex-M4 core with FPU
- ART + CCM-SRAM + Mathematic Accelerators
- Single Bank Flash with ECC
- SRAM with Parity bit
- +/- 1% internal clock
- 1.72 to 3.6V power supply
- Up to 125°C




- Advanced Motor Control timers
- Rich Advanced Analog
- CAN Flexible Data rate
- USB-C Power Delivery3.0
- Advanced Security and Safety features
- Robustness: highest level 5 / FTB/ESD - IEC 61000-4-4

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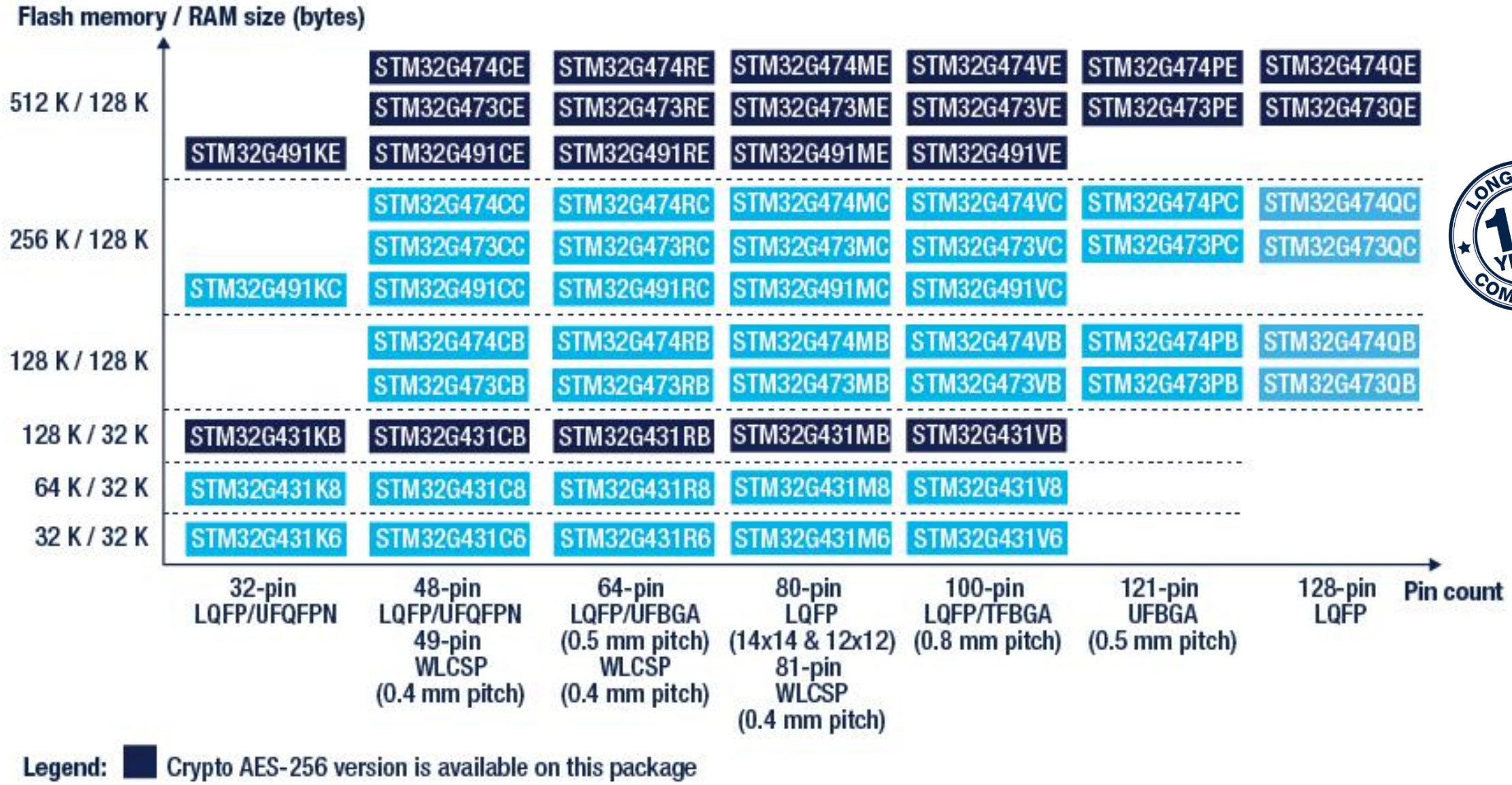
# STM32G4 portfolio



# Broad portfolio

## Portfolio extended to support budget applications efficiently

### More memory and pin counts

| Flash memory (bytes) | 32-pin LQFP QFN | 48-pin LQFP QFN WLCSP | 64-pin LQFP BGA WLCSP | 80-pin LQFP WLCSP | 100-pin LQFP BGA | 121-pin BGA | 128-pin LQFP |
|---|---|---|---|---|---|---|---|
| 512 K | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 256 K | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 128 K | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 64 K | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| 32 K | ✓ | ✓ | ✓ | ✓ | ✓ | | |

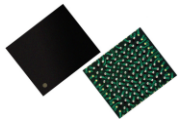
Note: latest packages introduction in STM32 portfolio

### More packages

WLCSP

QFN

LQFP



BGA

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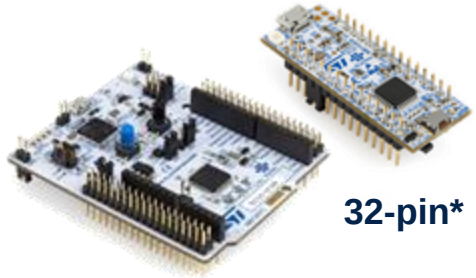
# STM32G4 hardware solutions

## Accelerate evaluation, prototyping and design




### STM32 Nucleo

**Flexible prototyping**

- NUCLEO-G431RB
- NUCLEO-G474RE
- NUCLEO-G431KB*
- NUCLEO-G491RE

### Evaluation boards

**Full feature STM32G4 evaluation**

- STM32G484E-EVAL
- STM32G474E-EVAL
- STM32G474E-EVAL1

### Motor Control Pack

**Full feature for Motor Control and Analog**

- P-NUCLEO-IHM03

### Discovery kits

**Key feature prototyping**

- B-G474E-DPOW1
- B-G431B-ESC1

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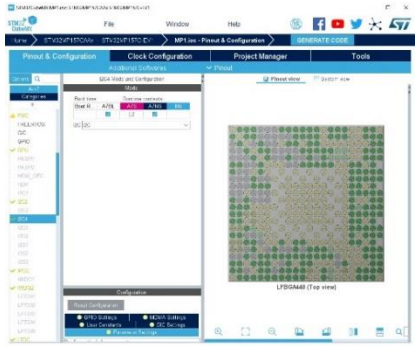
# STM32G4 software tools

## Complete support of Arm Cortex-M ecosystem

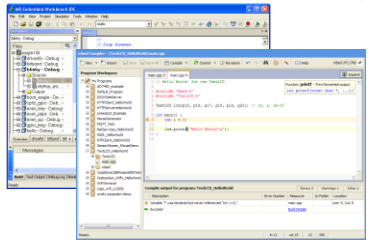
STM32 CubeMX



arm KEIL IAR SYSTEMS

eclipse

STM32 CubeIDE



All-in-one STM32 programming tool
Multi-mode, user-friendly


| STM32CubeMX | IDEs<br>Compile and Debug | STM32 Programming Tool |
|---|---|---|
| **STM32CubeMX**<br>• Configure and generate Code<br>• Conflicts solver | **Flexible Solutions**<br>• Partners IDE, like IAR and Keil<br>• Free IDE based on Eclipse, like STM32CubeIDE | **STM32CubeProgrammer**<br>• Flash and/or system memory<br>• GUI or command line interface |

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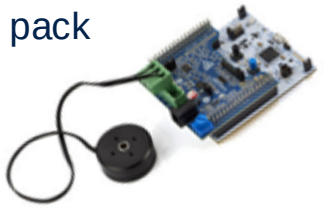
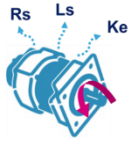
# Dedicated ecosystems

## Motor Control

- **Complete ecosystem** (HW boards, SW Development Kit (SDK), docs and trainings)
  - X-CUBE-MCSDK
    - Motor Control FW library based on STM32Cube HAL and LL
    - Motor control workbench: Graphical configurator of the motor control library linked with STM32CubeMx
  - P-NUCLEO-IHM03: Motor Control Nucleo pack
    - NUCLEO-G431RB Nucleo-64
    - X-NUCLEO-IHM16M1 motor driver expansion board
    - Low Voltage motor



- **State of the art algorithms** (FOC, 6-step, sensorless…)
- **Motor Profiler**: Plug and spin your motor within less than one minute




www.st.com/stm32-motor-control

## Digital Power

- **Complete ecosystem** (HW boards, FW examples, SW tools, docs and trainings)
- **Dedicated HRTIM Cookbook - AN4539:** How to operate the Hi-Resolution timer in different topology
- **Digital Power training** (PSU and PFC) – based on STM32 G4 series – done in collaboration with Biricha

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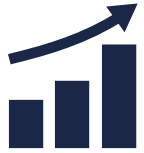
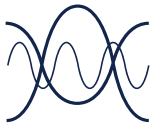
# STM32G4 series – takeaways

## Analog-rich MCUs for mixed-signal applications

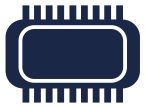


Performance
170 MHz Cortex-M4 coupled with three accelerators



Rich and Advanced Integrated Analog
ADC, DAC, op-amp, comparator

Safety and security focus
SIL and CLASSB Safety Packages, including Self-Test Library
Arm PSA Level 1 logical security certification



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