# STM32G4 Mainstream Series
# Mixed Signals MCU


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# Continuing the STM32 Success Story



## Leader in Arm® Cortex®-M 32-bit General Purpose MCU


**2007** — World 1st Cortex-M MCU — STM32 F1

**2009** — World 1st Cortex-M Ultra-low-power — STM32 L1

**2010** — 1st High Perf. 120 MHz, 90nm — STM32 F2

**2011** — 1st High Perf. Cortex-M4 168 MHz — STM32 F4

**2012** — 1st Mixed Signal DSP + Analog STM32F3 Cortex-M4 — STM32 F3

**2012** — Entry Cost STM32F0 Cortex-M0 — STM32 F0

**2013** — Entry Cost Ultra-low-power — STM32 L0

**2014** — World 1st Cortex-M7 — STM32 F7

**2015** — Leadership Ultra-low-power Cortex-M4 — STM32 L4

**2015** — #1 ULP 447 ULPBench™

**2016** — #1 Performance 2400 CoreMark — STM32 H7

**2016** — STM32 L4+

**2016** — Ultra-low-power Excellence

**2017** — Mainstream Cortex-M0+ MCUs Efficiency at its best! — STM32 G0

**2017** — Introduction of M33 Excellence in ULP with more security — STM32 L5

**2018** — STM32 WB

**2018** — Dual-core, multiprotocol and open radio

**2019** — STM32 MP1

**2019** — Multicore Microporcessor

**2019** — STM32 G4

**2019** — **Mixed-signal Cortex-M4**

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# Continuing the STM32 Success Story



## STM32G4 series in the continuity of the STM32F3 series


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**2019** — STM32 G4

**2019** — **Mixed-signal Cortex-M4**

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# STM32G4: Continuity in STM32 MCUs



## Keep releasing your growing creativity


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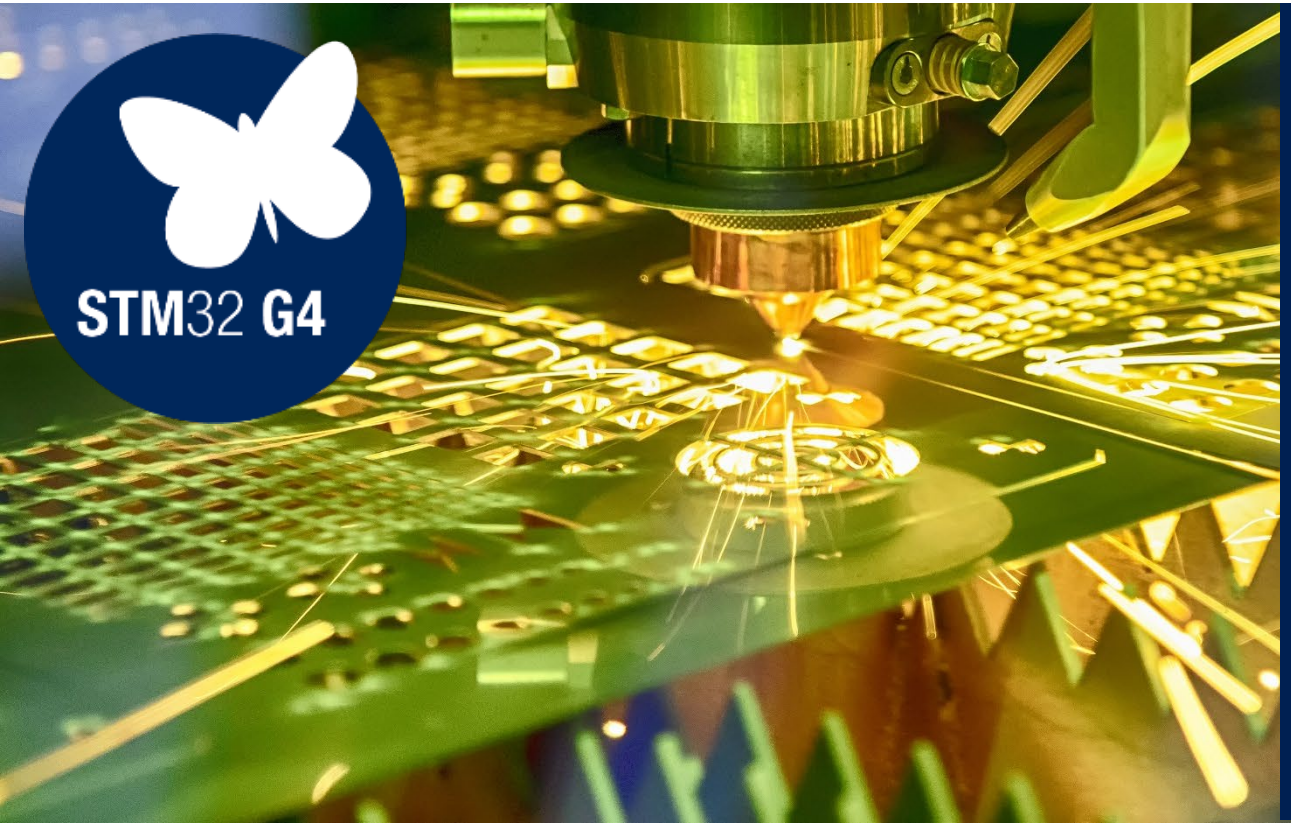
# STM32G4 Series



## Ideal for applications requiring MCU with advanced and rich analog peripherals

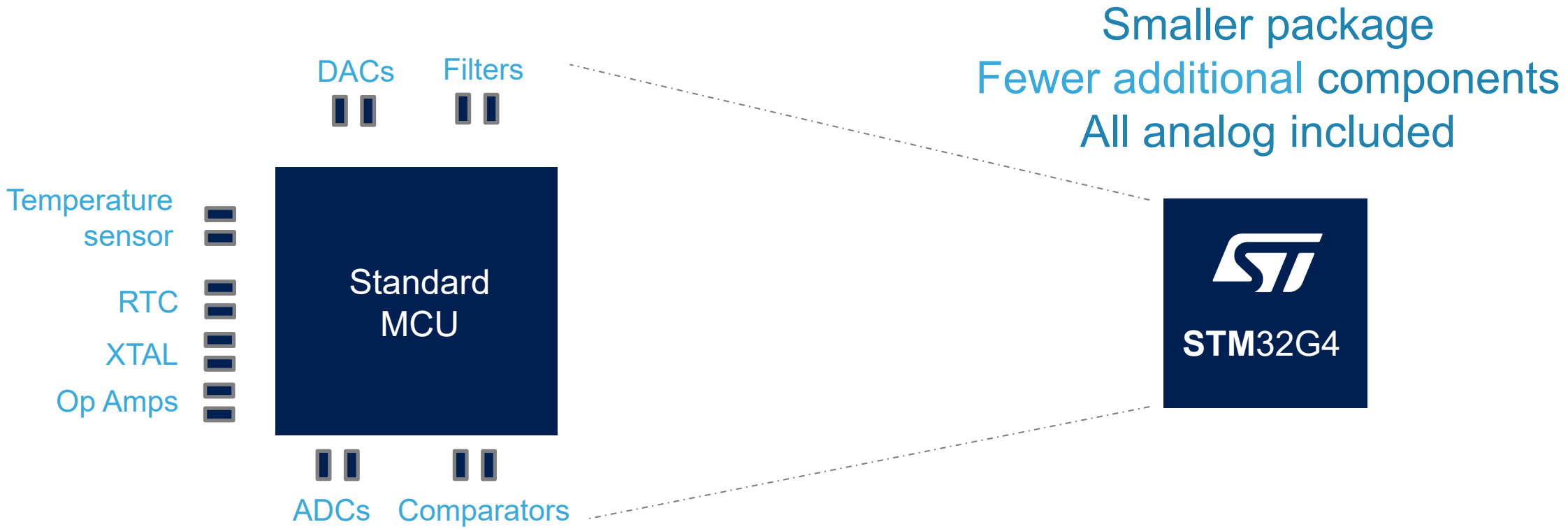



- Control applications (Motor Control…)
- Industrial equipment
- Instrumentation and Measurement
- Digital Power
  - Digital SMPS (switch mode power supply)
  - PFC (power factor correction)

# Reducing PCB Size and BOM Cost



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

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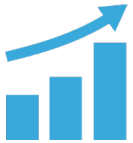
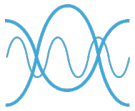
# STM32G4 Series – Key Messages





## Performance

- Arm® Cortex®-M4 at 170 MHz
- 213 DMIPS and 550 CoreMark® results
- Better dynamic power consumption (163µA/MHz)
- ART Accelerator™ (dynamic cache)
- Mathematical accelerators
- CCM-SRAM Routine Booster (static cache)



## Rich Integrated Analog and Digital

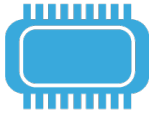
- Op-Amps (Built-in gain), DACs, Comparators
- 12-bit ADCs 4Msps with hardware oversampling
- CAN-FD (flexible data rate – 8Msps bit rate)
- High resolution timer (184 ps)
- USB type-C Power Delivery3.0
- 1% RC accuracy [-5°..90°C], 2% full T° range

## 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 32KB to 512KB Flash

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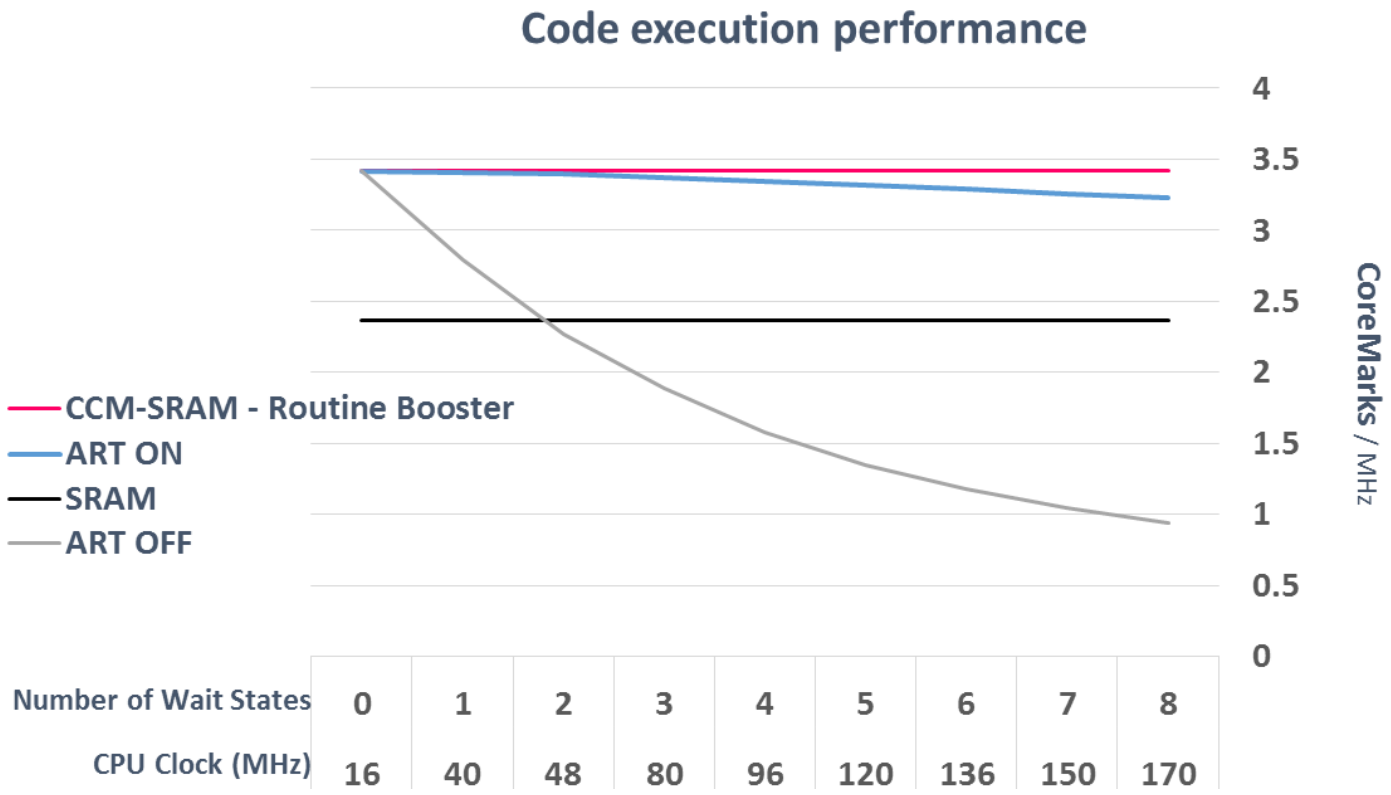
# Greater Performance

## Pure 170 MHz CPU performance (Arm® Cortex®-M4) with 3 accelerators




Arm Cortex-M4 with **FPU**

**Up to 170** MHz CPU frequency

**Up to 213 DMIPS and 550 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

NEW

# Mathematical Accelerators



## Function acceleration and CPU offload

### 1. Cordic (Trigo)

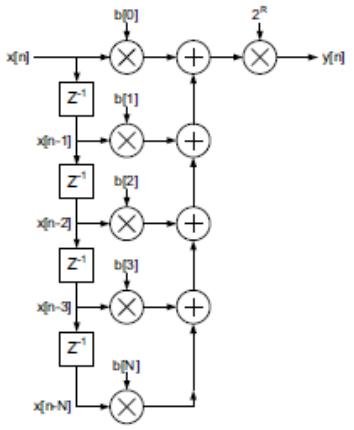
- Very helpful for Field Oriented Motor Control method (FOC)

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

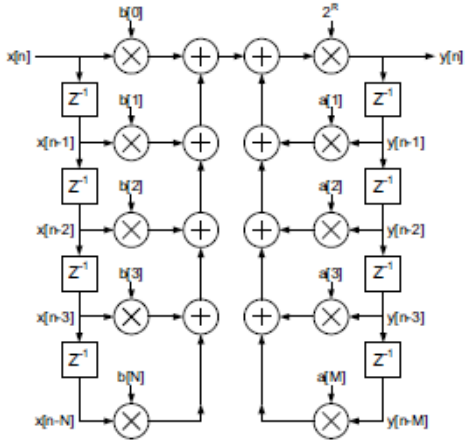
### 2. Filter Math ACcelerator (FMAC)

- Can be used to create
  - 3p3z Compensator (→ Digital power)
  - Sigma Delta modulator
  - Noise Shaper

**FIR filter**



**IIR filter**



# 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 |

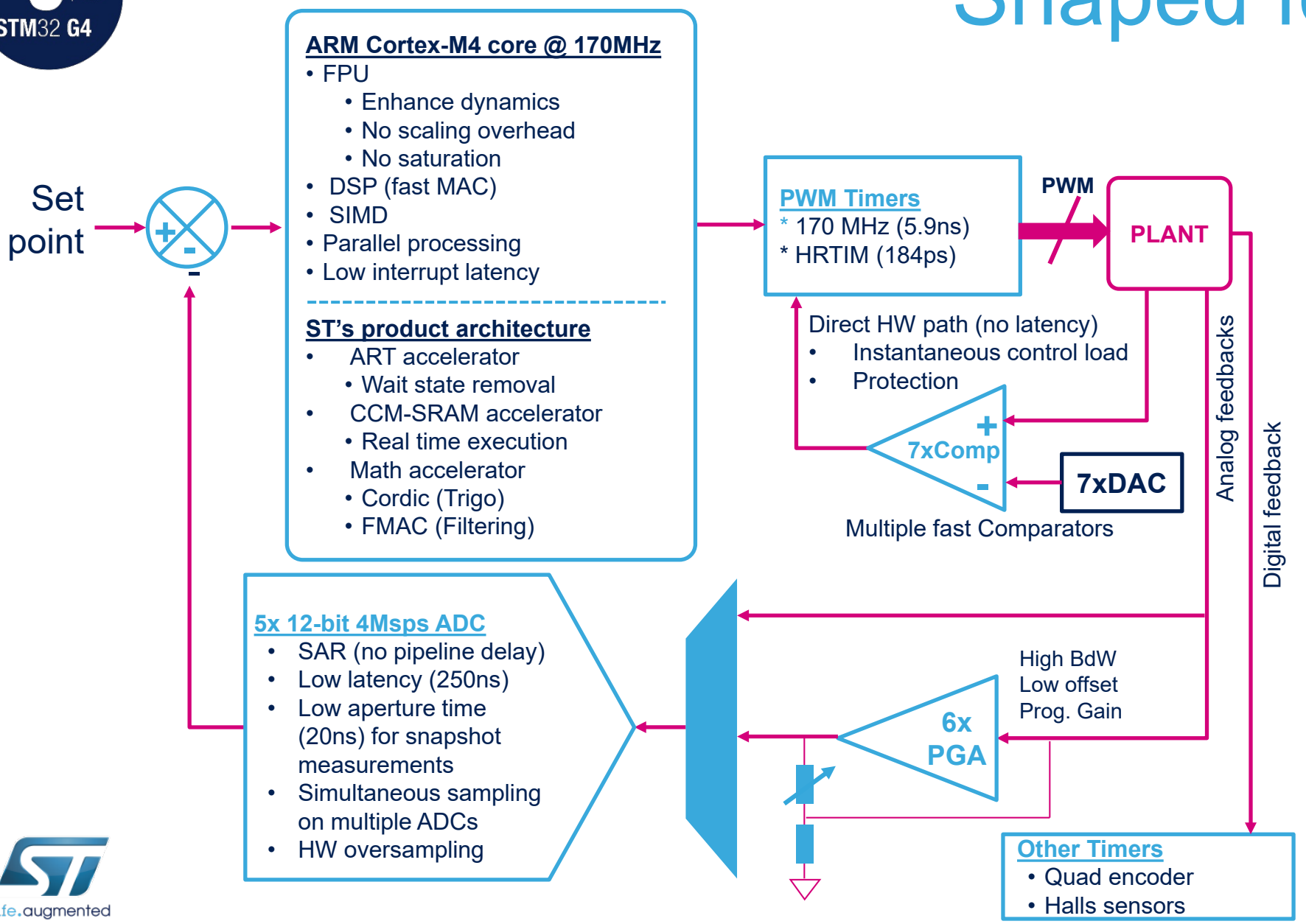
| DAC (up to 7) | Values |
|---|---|
| Sampling rate | **15 Msps** (internal)<br>1Msps (from buffered output) |
| Settling time | 16ns |

| Op-Amp (up to 6) | Values |
|---|---|
| GBW | **13 MHz** |
| Slew rate | **45 V/µs** |
| Offset | 3mV over full T° range<br>1.5mV @ 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 .. 3.6V |
| Propagation delay | **16.7ns** |
| Offset | -6 .. +2 mV |
| Hysteresis | 8 steps:<br>0, 9, 18, 27, 36, 45, 54, 63 mV |

# Shaped for Control






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

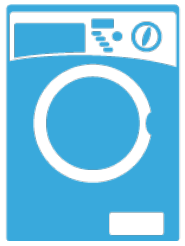
# Key Features for Targeted Applications



## Motor Control

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

- Fast CPU 170MHz
- 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

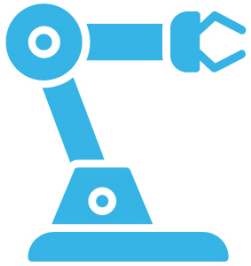
### Rechargeable devices, drones, toys

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

## Industrial devices Measurements

### Industrial equipment

- Fast CPU 170MHz
- 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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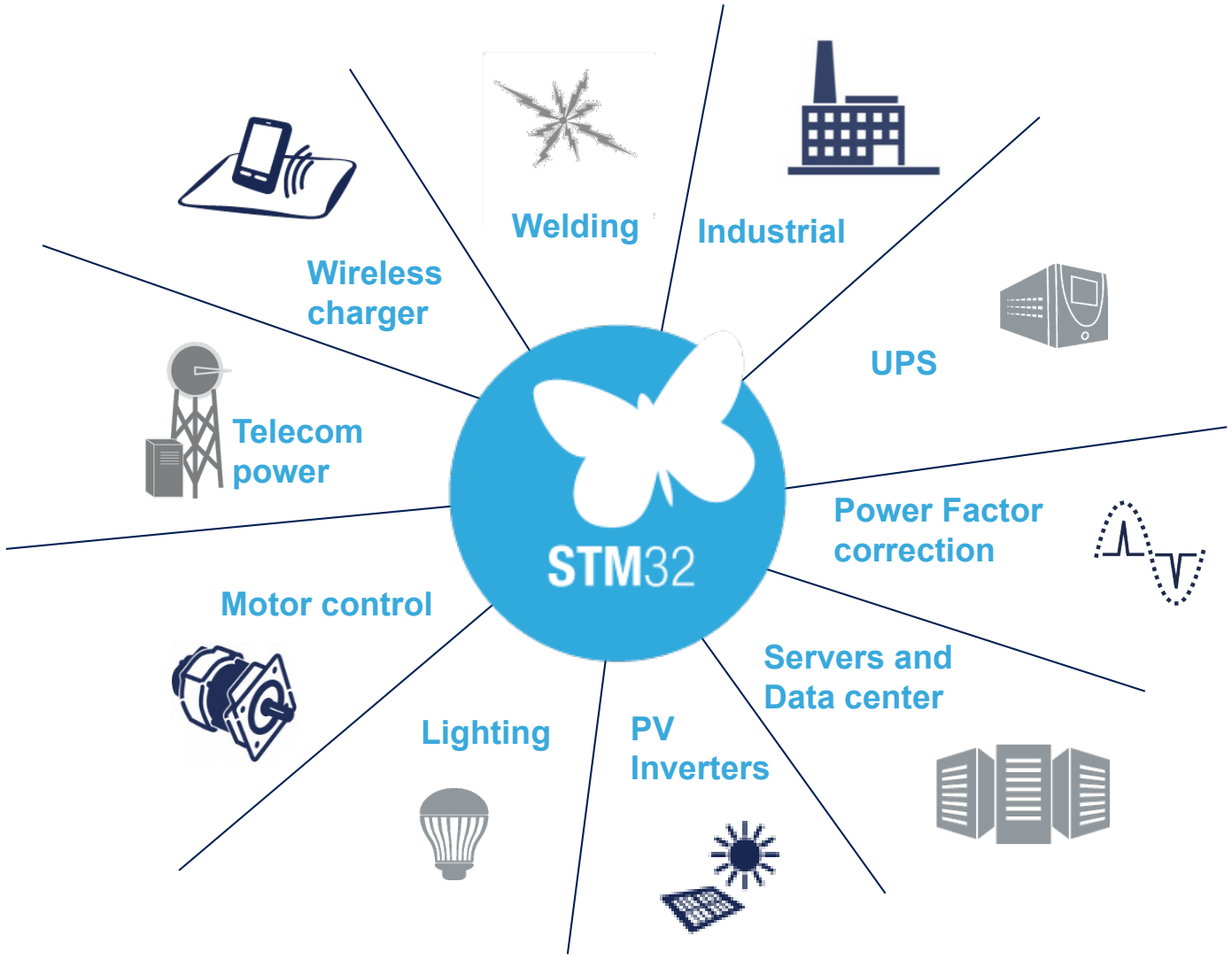
# Ease Digital Power Conversion



Enhance your digital power solutions using the STM32G4's full features High Resolution Timer (HRTIM)

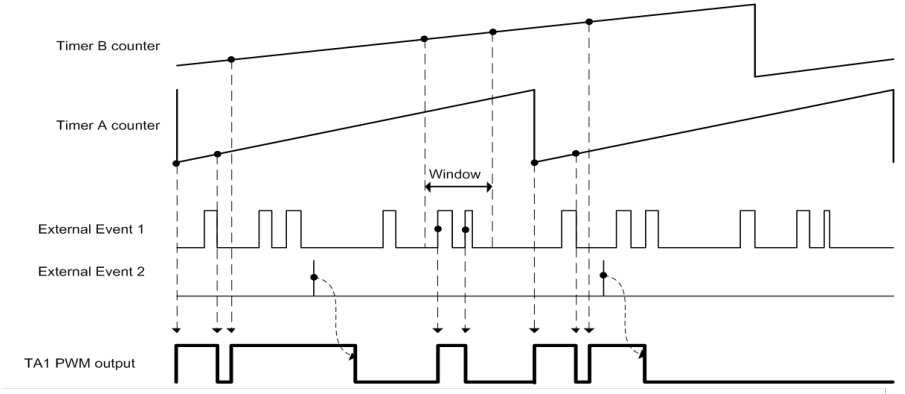


# HRTimer – Not only High Resolution…



## 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

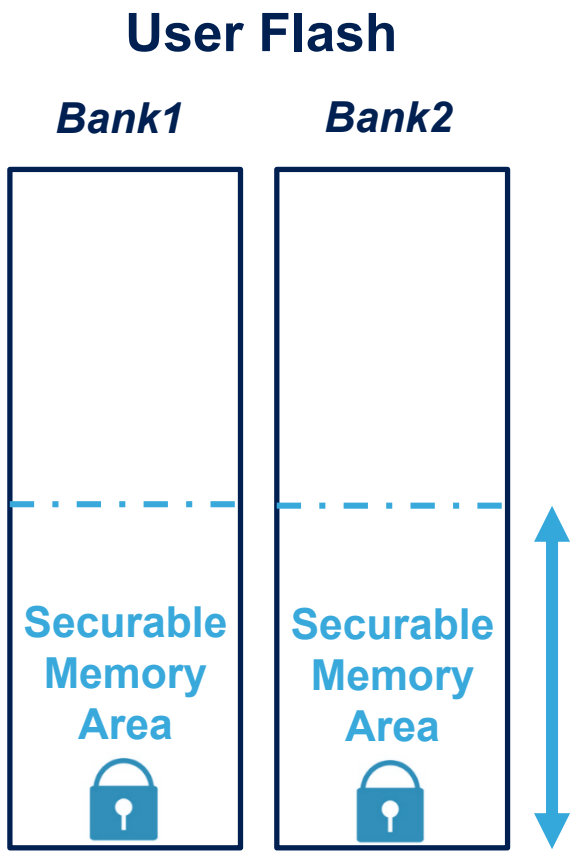
## 12 independent channels

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

# Greater Security

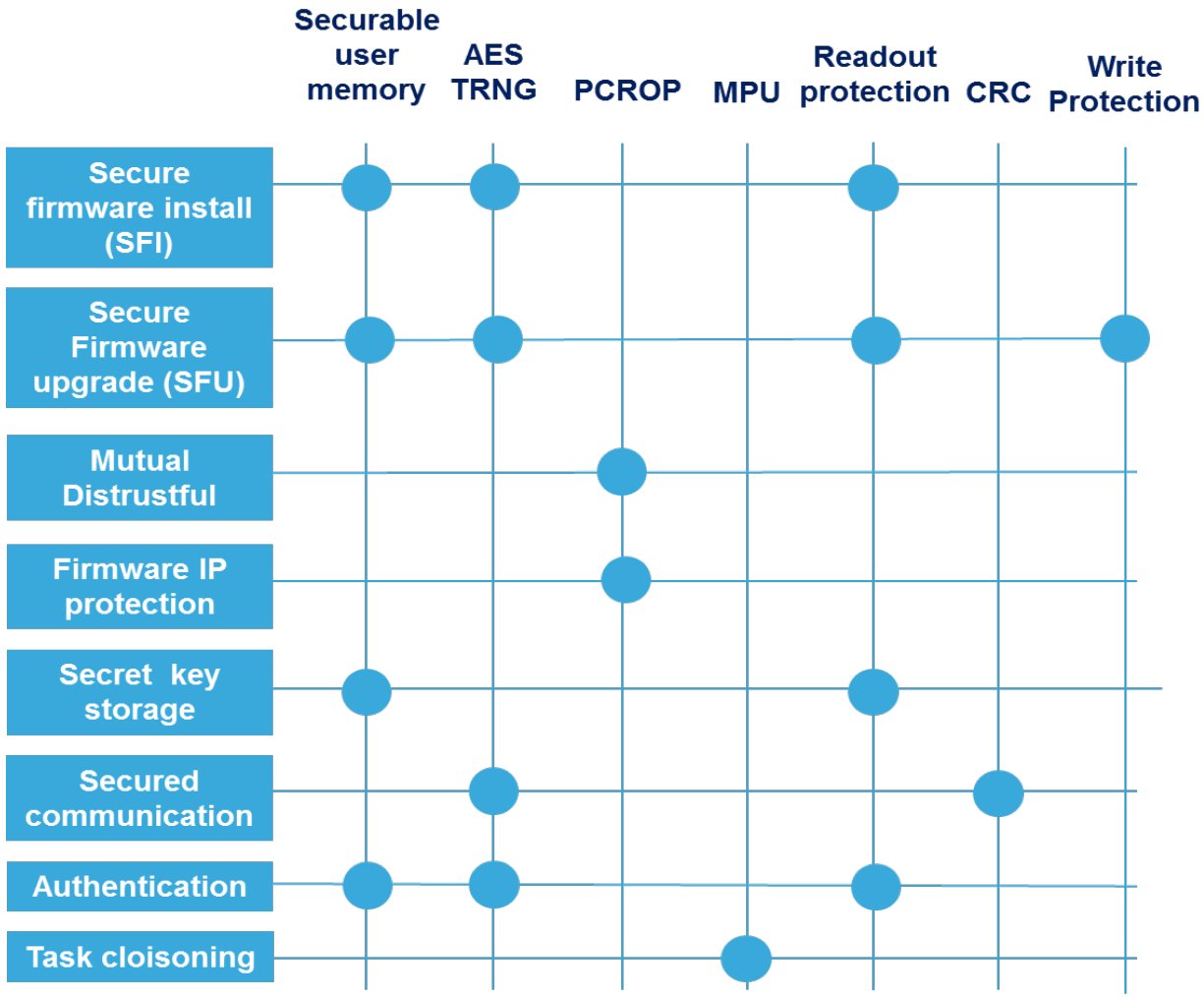


## Integrated security features, ready for tomorrow's needs




**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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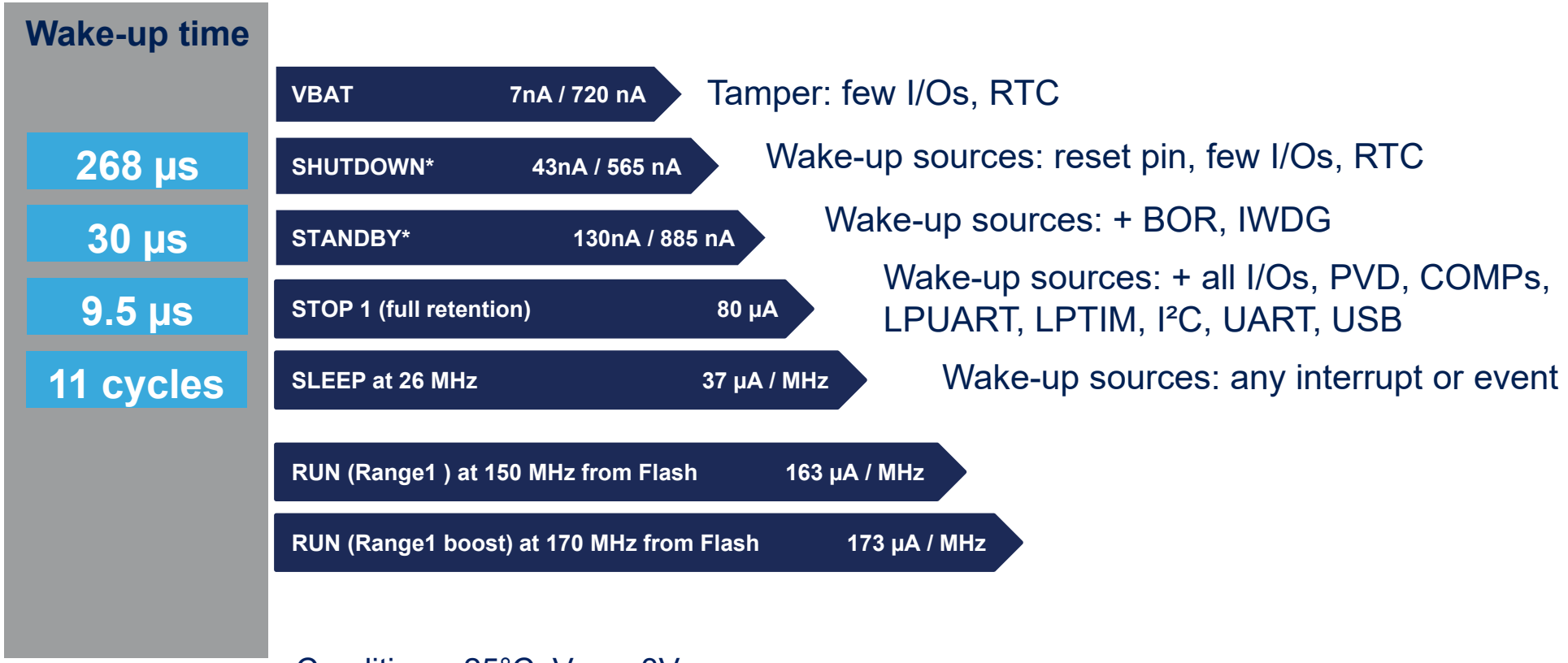
# Dynamic Efficiency Modes



## When Mainstream MCU Series meets low-power requirements



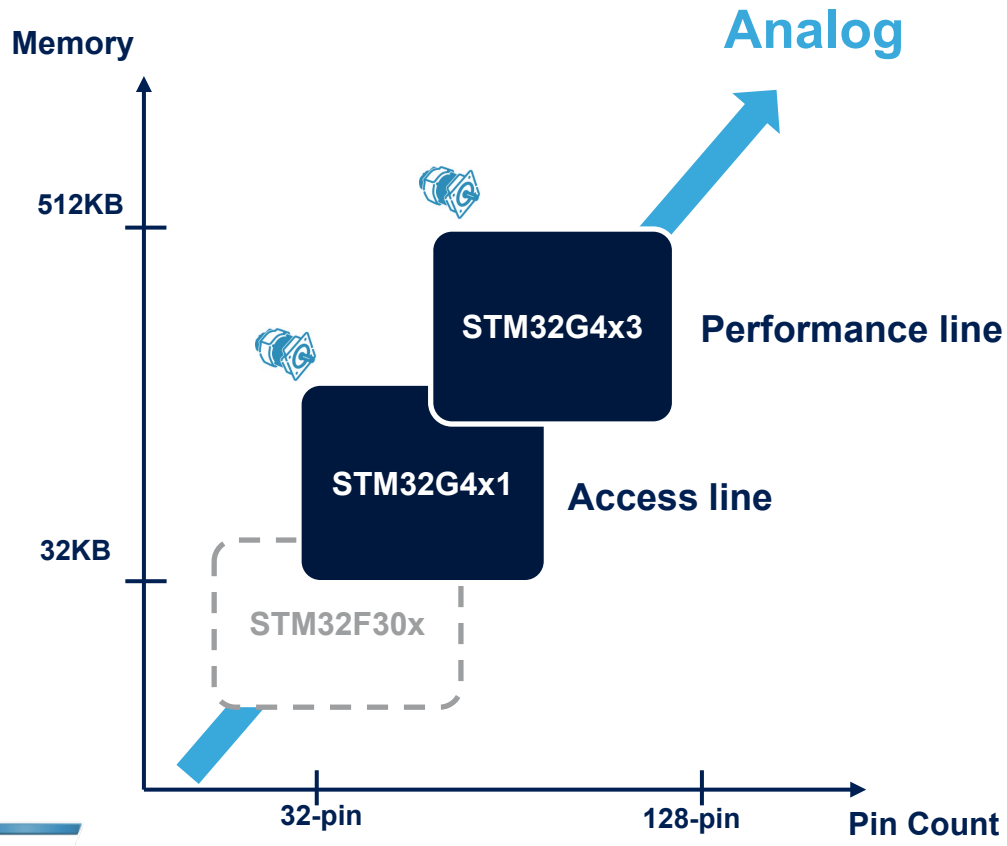

Conditions: 25°C, $V_{DD}$ = 3V

Note : * without RTC / with RTC

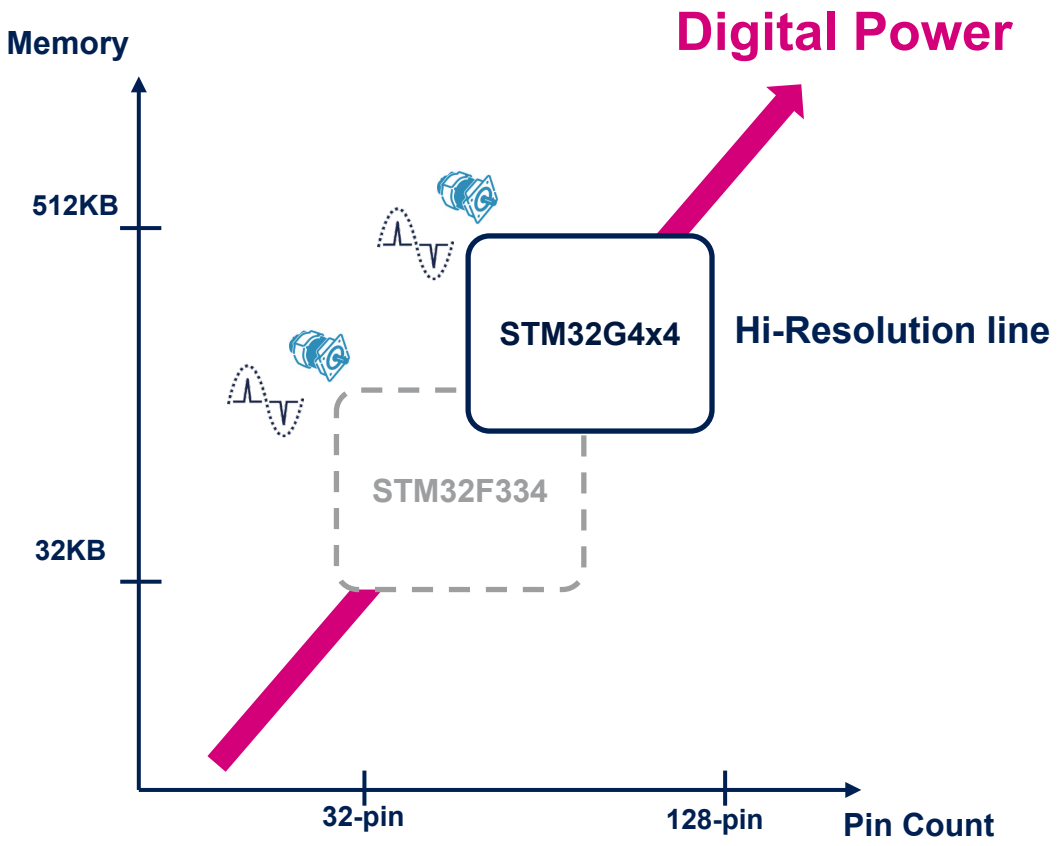
# STM32G4 Products Lines



## General Purpose




## Applications 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 |
|---|---|---|---|
| Core, frequency | Arm Cortex-M4, 170 MHz | | |
| Flash (max) | 512 Kbytes (2x256KB dual bank) | | 128 Kbytes single bank |
| RAM (up to) | 96 Kbytes | | 22 Kbytes |
| CCM –SRAM (code-SRAM) | 32 Kbytes | | 10 Kbytes |
| 12-bit ADC SAR | 4x 12-bit<br>4 MSPS | | 2x 12-bit<br>4 MSPS |
| Comparator | 7 | | 4 |
| Op amp with 4 built-in gain values with 1% accuracy | 6 | | 3 |
| 12-bit DAC | 7 | | 4 |
| Motor Control timer | 3x (170 MHz) | | 2x (170 MHz) |
| CAN-FD | 3x | | 1x |
| 12 channel Hi-resolution Timer | 1x | - | - |
| Power supply | 1.72 to 3.6 V | | |

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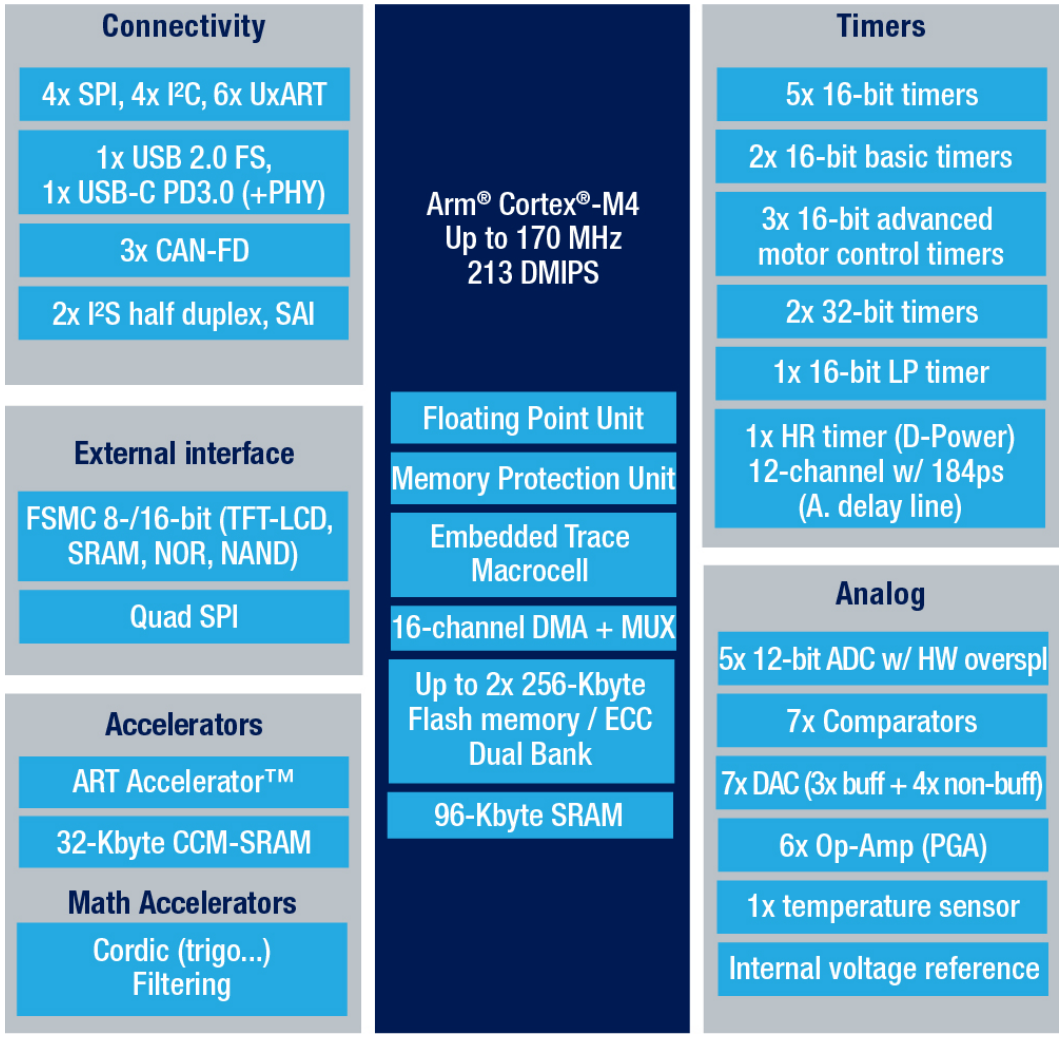
# High Resolution and Performance lines [128KB .. 512KB]

- 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
- 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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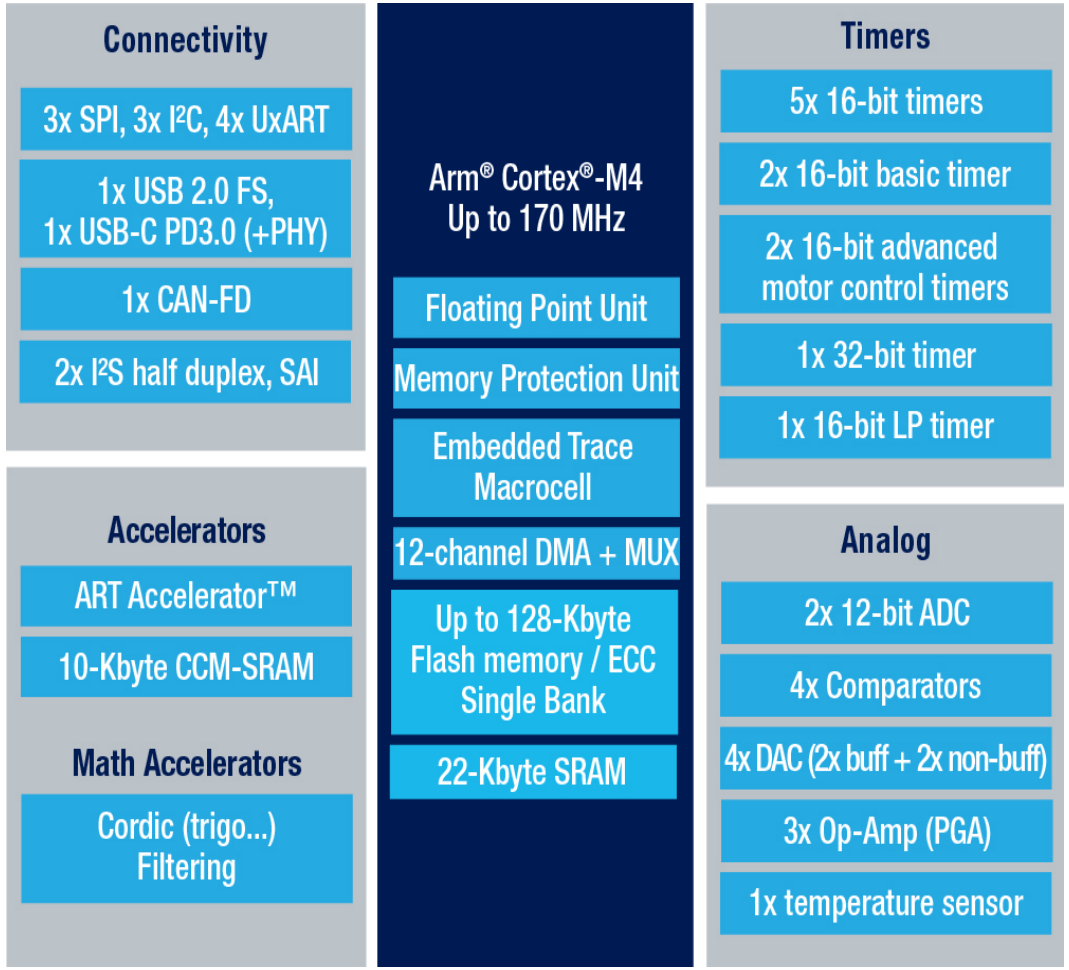
# Access line [32KB .. 128KB] and up to 512KB in H1-2020 !

- 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




- 2x 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




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# Broad Portfolio



## Portfolio extended to support budget applications efficiently

### More memory and pin counts

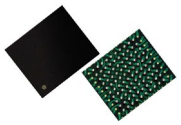
| Flash memory (bytes) | 32-pin LQFP QFN | 48-pin LQFP QFN | 64-pin LQFP BGA WLCSP | 80-pin LQFP WLCSP | 100-pin LQFP BGA | 121-pin BGA | 128-pin LQFP |
|---|---|---|---|---|---|---|---|
| 512 K | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 256 K | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 128 K | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 64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

### More packages

WLCSP

QFN

LQFP



BGA

Note: new packages in STM32 portfolio

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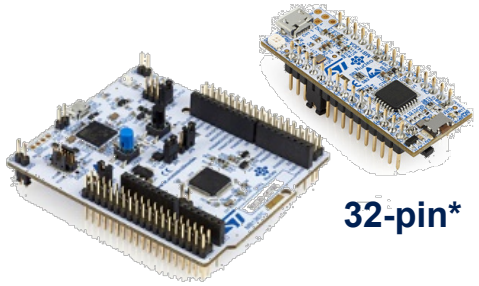
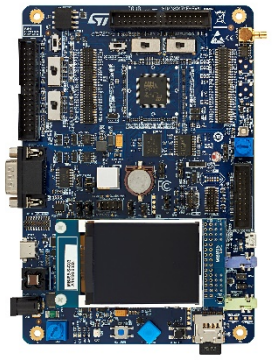
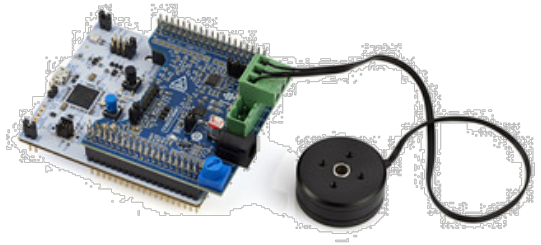
# STM32G4 Hardware Solutions



## Accelerate evaluation, prototyping and design





### STM32 Nucleo

**Flexible prototyping**

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

### 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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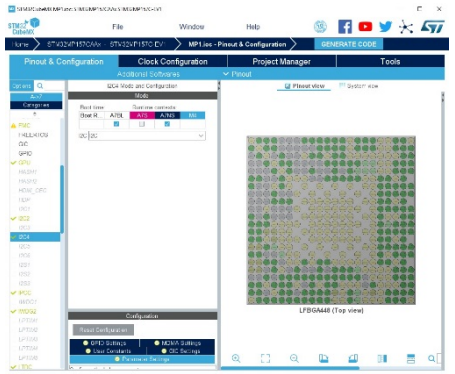
Available now from distributor stocks

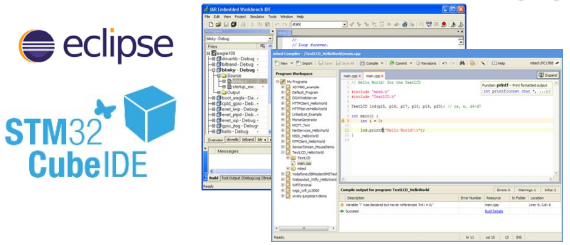
* Available in distributor stocks from Q3-2019

# STM32G4 Software Tools



## Complete support of Arm Cortex-M ecosystem





### STM32CubeMX

**STM32CubeMX**

- Configure and generate Code
- Conflicts solver

### IDEs
Compile and Debug

**Flexible Solutions**

- Partners IDE, like IAR and Keil
- Free IDE based on Eclipse, like STM32CubeIDE*

### STM32 Programming Tool

**STM32CubeProgrammer**

- Flash and/or system memory
- GUI or command line interface

* SW examples will be available in Q4 19

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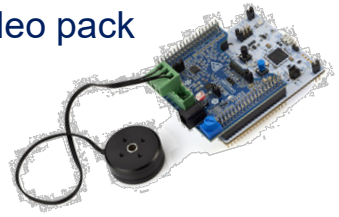
# Dedicated Ecosystems

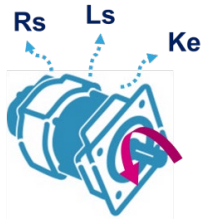


## Motor Control

- **Complete ecosystem** (HW boards, SW Development Kit (SDK), docs and trainings)
  - X-CUBE-MCSDK (v5.4)
    - 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



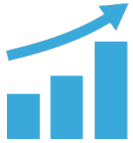

## Digital Power

- **Complete ecosystem** (HW boards, FW examples, SW tools, docs and trainings)
- **Dedicated HRTIM Cook Book - 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 (from Q4 2019)

# STM32G4 Series – Take Away

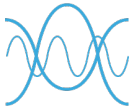


## Analog-rich MCUs for mixed-signal applications



### Performance

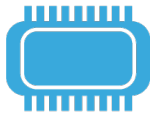
170MHz Cortex-M4 coupled with 3x accelerators



### Rich and Advanced Integrated Analog

ADC, DAC, Op-Amp, Comp.

### Safety and security focus



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