STM32G4 mainstream series
mixed signal MCU
### STM32G4 series

**continuity of the STM32F3**

<table>
<thead>
<tr>
<th>Category</th>
<th>Model</th>
<th>CoreMark</th>
<th>MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPU</td>
<td>STM32MP1</td>
<td>4158</td>
<td>650</td>
</tr>
<tr>
<td>MPU</td>
<td>STM32MP1</td>
<td></td>
<td>209</td>
</tr>
<tr>
<td>High Perf MCUs</td>
<td>STM32F0</td>
<td>106</td>
<td>48</td>
</tr>
<tr>
<td>High Perf MCUs</td>
<td>STM32G0</td>
<td>142</td>
<td>64</td>
</tr>
<tr>
<td>Mainstream MCUs</td>
<td>STM32F1</td>
<td>177</td>
<td>72</td>
</tr>
<tr>
<td>Mainstream MCUs</td>
<td>STM32F2</td>
<td>398</td>
<td>120</td>
</tr>
<tr>
<td>Mainstream MCUs</td>
<td>STM32F3</td>
<td>245</td>
<td>72</td>
</tr>
<tr>
<td>Mainstream MCUs</td>
<td>STM32F4</td>
<td>608</td>
<td>180</td>
</tr>
<tr>
<td>Ultra-low Power MCUs</td>
<td>STM32L0</td>
<td>75</td>
<td>32</td>
</tr>
<tr>
<td>Ultra-low Power MCUs</td>
<td>STM32L1</td>
<td>93</td>
<td>32</td>
</tr>
<tr>
<td>Ultra-low Power MCUs</td>
<td>STM32L5</td>
<td>242</td>
<td>110</td>
</tr>
<tr>
<td>Ultra-low Power MCUs</td>
<td>STM32L4</td>
<td>273</td>
<td>80</td>
</tr>
<tr>
<td>Ultra-low Power MCUs</td>
<td>STM32L4+</td>
<td>409</td>
<td>120</td>
</tr>
<tr>
<td>Wireless MCUs</td>
<td>STM32WL</td>
<td>161</td>
<td>48</td>
</tr>
<tr>
<td>Wireless MCUs</td>
<td>STM32WB</td>
<td>216</td>
<td>64</td>
</tr>
</tbody>
</table>

**Arm® Cortex® core**

- M0
- M0+
- M3
- M33
- M4
- M7

**Cortex-M0+ Radio co-processor**

- dual -A7 & -M4
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)
Reducing PCB size and BOM cost

System-on-Chip – All-in-one solution

- Smaller package
- Fewer additional components
- All analog included

STM32G4

DACs
Filters

Temperature sensor
RTC
XTAL
Op Amps

Standard MCU

ADCs
Comparators

Project cost $$$
Project cost $

XTAL 4
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 – 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
Greater performance

Pure 170 MHz CPU performance (Arm® Cortex®-M4) with three 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)
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
Rich, advanced analog

Mixed-signal SoC for wide variety of applications

<table>
<thead>
<tr>
<th>ADC (up to 5)</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topology</td>
<td>SAR 12-bit + HW oversampling → 16-bit</td>
</tr>
<tr>
<td>Sampling rate</td>
<td>Up to 4 Msp</td>
</tr>
<tr>
<td>Input</td>
<td>Single-ended and differential</td>
</tr>
<tr>
<td>Offset and Gain compensation</td>
<td>Auto calibration to reduce gain and offset</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DAC (up to 7)</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling rate</td>
<td>15 Msp (internal)</td>
</tr>
<tr>
<td></td>
<td>1 Msp (from buffered output)</td>
</tr>
<tr>
<td>Settling time</td>
<td>16 ns</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Comparator (up to 7)</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>1.62..3.6 V</td>
</tr>
<tr>
<td>Propagation delay</td>
<td>16.7 ns</td>
</tr>
<tr>
<td>Offset</td>
<td>-6..+2 mV</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>8 steps: 0, 9, 18, 27, 36, 45, 54, 63 mV</td>
</tr>
</tbody>
</table>
Shaped for control

ARM Cortex-M4 core @ 170 MHz
• FPU
  • Enhance dynamics
  • No scaling overhead
  • No saturation
• DSP (fast MAC)
• SIMD
• Parallel processing
• Low interrupt latency

ST’s product architecture
• ART accelerator
  • Wait state removal
  • CCM-SRAM accelerator
  • Real time execution
• Math accelerator
  • Cordic (Trigo)
  • FMAC (Filtering)

5x 12-bit 4Msps ADC
• SAR (no pipeline delay)
• Low latency (250 ns)
• Low aperture time (20 ns) for snapshot measurements
• Simultaneous sampling on multiple ADCs
• HW oversampling

PWM Timers
• 170 MHz (5.9 ns)
• HRTIM (184 ps)

PWM
PLANT

Set point

Digital feedback

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

High BdW
Low offset
Prog. Gain

6x PGA

Other Timers
• Quad encoder
• Halls sensors

Multiple fast Comparators

7x Comp

7xDAC

Parallel processing

No scaling overhead

No saturation

Low interrupt latency

Instantaneous control load

Protection

Direct HW path (no latency)
Key features for targeted applications

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

**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

**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

**High-End Consumer**

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

**Digital Power**
Ease digital power conversion

Enhance your digital power solutions using the STM32G4 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

**User Flash**
- **Bank1**
- **Bank2**

**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

**Securable Memory Area**

**Diagram:**
- Secure firmware install (SFI)
- Secure Firmware upgrade (SFU)
- Mutual Distrustful
- Firmware IP protection
- Secret key storage
- Secured communication
- Authentication
- Task cloisoning

**Table:**
- Secure user memory
- AES
- TRNG
- PCROP
- MPU
- Readout protection
- CRC
- Write Protection
# Dynamic efficiency modes

When Mainstream MCU Series meets low-power requirements

<table>
<thead>
<tr>
<th>Wake-up Time</th>
<th>Current (Wake-up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>268 µs</td>
<td>7nA / 720 nA</td>
</tr>
<tr>
<td>30 µs</td>
<td>43nA / 565 nA</td>
</tr>
<tr>
<td>9.5 µs</td>
<td>130nA / 885 nA</td>
</tr>
<tr>
<td>11 cycles</td>
<td>80 µA</td>
</tr>
<tr>
<td></td>
<td>37 µA / MHz</td>
</tr>
<tr>
<td></td>
<td>163 µA / MHz</td>
</tr>
<tr>
<td></td>
<td>173 µA / MHz</td>
</tr>
</tbody>
</table>

### Wake-up Sources:
- **Tamper**: few I/Os, RTC
  - Wake-up sources: reset pin, few I/Os, RTC
  - Wake-up sources: + BOR, IWDG
  - Wake-up sources: + all I/Os, PVD, COMPs, LPUART, LPTIM, I²C, UART, USB
  - Wake-up sources: any interrupt or event

### Conditions:
- $25^\circ C$, $V_{DD} = 3V$

### Note
- * without RTC / with RTC
STM32G4 products lines

General Purpose

STM32G4x1
STM32G4x3
STM32F30x

Analog

512KB
32KB

Memory
Pin Count

Performance line
Access line

STM32G4x3
STM32G4x1
STM32F30x

Application Specific

Digital Power

512KB
32KB

Memory
Pin Count

Hi-Resolution line

STM32G4x4
STM32F334

Performance line
Access line

STM32G4x3
STM32G4x1
STM32F30x

512KB
32KB

Memory
Pin Count

STM32G4x4
STM32F334

Performance line
Access line

STM32G4x3
STM32G4x1
STM32F30x
Extensive & innovative peripheral set

No compromise on what matters

<table>
<thead>
<tr>
<th>Unit parameters</th>
<th>STM32G474 Hi-Resolution line</th>
<th>STM32G473 Performance line</th>
<th>STM32G431 Access line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core, frequency</td>
<td>Arm Cortex-M4, 170 MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash (max)</td>
<td>512 Kbytes (2x256 KB dual bank)</td>
<td>128 Kbytes single bank</td>
<td></td>
</tr>
<tr>
<td>RAM (up to)</td>
<td>96 Kbytes</td>
<td>22 Kbytes</td>
<td></td>
</tr>
<tr>
<td>CCM –SRAM (code-SRAM)</td>
<td>32 Kbytes</td>
<td>10 Kbytes</td>
<td></td>
</tr>
<tr>
<td>12-bit ADC SAR</td>
<td>4x 12-bit 4 MSPS</td>
<td>2x 12-bit 4 MSPS</td>
<td></td>
</tr>
<tr>
<td>Comparator</td>
<td>7</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Opamp with 4 built-in gain values with 1% accuracy</td>
<td>6</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>12-bit DAC</td>
<td>7</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Motor Control timer</td>
<td>3x (170 MHz)</td>
<td>2x (170 MHz)</td>
<td></td>
</tr>
<tr>
<td>CAN-FD</td>
<td>3x</td>
<td>1x</td>
<td></td>
</tr>
<tr>
<td>12 channel Hi-resolution Timer</td>
<td>1x</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Power supply</td>
<td>1.72 to 3.6 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## STM32G47x

### 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**

<table>
<thead>
<tr>
<th>Connectivity</th>
<th>Timers</th>
</tr>
</thead>
<tbody>
<tr>
<td>4x SPI, 4x FC, 6x UXART</td>
<td>5x 16-bit timers</td>
</tr>
<tr>
<td>1x USB 2.0 FS, 1x USB-C PD3.0 (+PHY)</td>
<td>2x 16-bit timers</td>
</tr>
<tr>
<td>3x CAN-FD</td>
<td>3x 16-bit basic timers</td>
</tr>
<tr>
<td>2x PS half duplex, SAI</td>
<td>2x 16-bit advanced motor control timers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>External interface</th>
<th>Analog</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSLC 8-/16-bit (TFT-LCD, SRAM, NOR, NAND)</td>
<td>5x 12-bit ADC w/ HW overspl</td>
</tr>
<tr>
<td>Quad SPI</td>
<td>7x Comparators</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accelerators</th>
<th>Analog</th>
</tr>
</thead>
<tbody>
<tr>
<td>ART Accelerator™</td>
<td>7x DAC (3x buff + 4x non-buff)</td>
</tr>
<tr>
<td>32-Kbyte CCM-SRAM</td>
<td>6x Op-Amp (PGA)</td>
</tr>
<tr>
<td>Math Accelerators</td>
<td>1x temperature sensor</td>
</tr>
<tr>
<td>Cordic (trigo...) Filtering</td>
<td>Internal voltage reference</td>
</tr>
</tbody>
</table>

- **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**
• 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

STM32G43x

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

• 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
STM32G4 portfolio

Legend:
- Crypto AES-256
- Available in H1 2020
**Portfolio extended to support budget applications efficiently**

**More memory and pin counts**

<table>
<thead>
<tr>
<th>Flash memory (bytes)</th>
<th>32-pin LQFP QFN</th>
<th>48-pin LQFP QFN</th>
<th>64-pin LQFP BGA WLCSP</th>
<th>80-pin LQFP WLCSP</th>
<th>100-pin LQFP BGA</th>
<th>121-pin BGA</th>
<th>128-pin LQFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>512 K</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>256 K</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>128 K</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>64 K</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>32 K</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**More packages**

- WLCSP
- QFN
- LQFP
- BGA

Note: new packages in STM32 portfolio
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-DPOWER1*
  - B-G431B-ESC1*
Complete support of Arm Cortex-M ecosystem

**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

STM32G4 software tools
## 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 – takeaways

Analog-rich MCUs for mixed-signal applications

- **Performance**
  - 170 MHz Cortex-M4 coupled with three accelerators

- **Rich and Advanced Integrated Analog**
  - ADC, DAC, opamp, comparator

- **Safety and security focus**

- **Large portfolio available from NOW!**
  - 32..512KB Flash memory
  - 32..128-pin packages
Releasing your creativity

/STM32

@ST_World

community.st.com

www.st.com/STM32G4
Thank you