STM32G4 Mainstream Series
Mixed Signals MCU
Continuing the STM32 Success Story

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

- World 1st Cortex-M MCU
- World 1st Cortex-M Ultra-low-power
- 1st High Perf. Cortex-M4 120 MHz, 90nm
- 1st High Perf. Cortex-M4 168 MHz
- 1st Mixed Signal DSP + Analog STM32F3 Cortex-M4
- Entry Cost STM32F0 Cortex-M0
- Entry Cost Ultra-low-power
- World 1st Cortex-M7
- Leadership Ultra-low-power Cortex-M4
- #1 ULP 447 ULPBench™
- #1 Performance 2400 CoreMark
- Ultra-low-power Excellence
- Dual-core, multprotocol and open radio
- Mainstream Cortex-M0+ MCUs Efficiency at its best!
- Introduction of M33 Excellence in ULP with more security
- Multicore Microporcessor
- Mixed-signal Cortex-M4

Continuing the STM32 Success Story

STM32G4 series in the continuity of the STM32F3 series

1st Mixed Signal DSP + Analog
STM32F3 Cortex-M4

World 1st Cortex-M MCUs
Ultra-low-power

World 1st Cortex-M Ultra-low-power
1st High Perf. 120 MHz, 90nm

1st High Perf. Cortex-M4 168 MHz
Entry Cost Ultra-low-power
STM32F0 Cortex-M0

Mainstream Cortex-M0+ MCUs
Efficiency at its best!

Introduction of M33 Excellence in ULP with more security

Multicore Microprocessor

Ultra-low-power Excellence
#1 ULP 447 ULPBench™

Leadership Ultra-low-power Cortex-M4

STM32G4
Mixed-signal Cortex-M4

Entry Cost

1st Mixed Signal
double-core, multiprotocol and open radio

STM32F3
STM32F4
STM32F2
STM32F1
STM32F0
STM32L4
STM32L3
STM32L2
STM32L1
STM32L0
STM32L5
STM32L7
STM32H7
STM32W1
STM32MP1
STM32M0

## STM32G4: Continuity in STM32 MCUs

*Keep releasing your growing creativity*

<table>
<thead>
<tr>
<th>High-performance</th>
<th>Mainstream</th>
<th>Ultra-low-power</th>
<th>Wireless</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STM32 F2</td>
<td>STM32 L0</td>
<td>Cortex-M0</td>
</tr>
<tr>
<td></td>
<td>STM32 F3</td>
<td>STM32 L1</td>
<td>Cortex-M0+</td>
</tr>
<tr>
<td></td>
<td>STM32 F4</td>
<td>STM32 L5</td>
<td>Cortex-M3</td>
</tr>
<tr>
<td></td>
<td>STM32 F7</td>
<td>STM32 L4</td>
<td>Cortex-M33</td>
</tr>
<tr>
<td></td>
<td>STM32 H7</td>
<td>STM32 L4+</td>
<td>Cortex-M4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cortex-M7</td>
</tr>
</tbody>
</table>

**arm**

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

**NEW**

**LONGEVITY COMMITMENT**

10 years
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

- Smaller package
- Fewer additional components
- All analog included

Standard MCU

DACs
Filters

Temperature sensor
RTC
XTAL
Op Amps

ADCs
Comparators

STM32G4

Project cost $$$

Project cost $
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°C..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
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)
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**

<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 <strong>4 Msps</strong></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>
</table>
| Sampling rate | **15 Msps** (internal)  
**1Msps** (from buffered output) |
| Settling time | 16ns |

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

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

**ARM Cortex-M4 core @ 170MHz**
- 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)

**PWM Timers**
- 170 MHz (5.9ns)
- HRTIM (184ps)

**Digital feedback**
- High BdW
- Low offset
- Prog. Gain

**Analog feedbacks**
- Instantaneous control load
- Protection

**Set point**

**Other Timers**
- Quad encoder
- Halls sensors

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

**6x PGA**

**Easy use of the Analog and Digital resources thanks to high peripherals interconnect and flexible bus matrix**
Key Features for Targeted Applications

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)

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

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

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

Motor Control

Digital Power

High-End Consumer

Measurements

Industrial devices
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))
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

**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

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

- Secure user memory
- AES TRNG
- PCROP
- MPU
- Readout protection
- CRC
- Write Protection
# Dynamic Efficiency Modes

When Mainstream MCU Series meets low-power requirements

## Wake-up time

<table>
<thead>
<tr>
<th>Mode</th>
<th>Current (μA)</th>
<th>Frequency (MHz)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBAT</td>
<td>7nA / 720 nA</td>
<td></td>
<td>Tamper: few I/Os, RTC</td>
</tr>
<tr>
<td>SHUTDOWN*</td>
<td>43nA / 565 nA</td>
<td></td>
<td>Wake-up sources: reset pin, few I/Os, RTC</td>
</tr>
<tr>
<td>STANDBY*</td>
<td>130nA / 885 nA</td>
<td></td>
<td>Wake-up sources: + BOR, IWDG</td>
</tr>
<tr>
<td>STOP 1 (full retention)</td>
<td>80 μA</td>
<td></td>
<td>Wake-up sources: + all I/Os, PVD, COMPs, LPUART, LPTIM, I²C, UART, USB</td>
</tr>
<tr>
<td>SLEEP at 26 MHz</td>
<td>37 μA / MHz</td>
<td></td>
<td>Wake-up sources: any interrupt or event</td>
</tr>
<tr>
<td>RUN (Range1) at 150 MHz from Flash</td>
<td>163 μA / MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RUN (Range1 boost) at 170 MHz from Flash</td>
<td>173 μA / MHz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conditions: 25°C, \(V_{DD} = 3V\)

*Note:* * without RTC / with RTC
STM32G4 Products Lines

STM32G4x3
- Performance line
- Analog
- Memory: 512KB
- Pin Count: 128-pin

STM32G4x1
- Access line
- Analog
- Memory: 32KB
- Pin Count: 32-pin

STM32F30x

STM32G4x4
- Hi-Resolution line
- Digital Power
- Memory: 512KB
- Pin Count: 128-pin

STM32F334

STM32G4x1
- Analog
- Memory: 32KB
- Pin Count: 32-pin

STM32G4x3
- Performance line
- Analog
- Memory: 512KB
- Pin Count: 128-pin
## 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 (2x256KB 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>Op amp 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>
• 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

STM32G47x

High Resolution and Performance lines [128KB .. 512KB]
STM32G43x

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

Connectivity
- 3x SPI, 3x I²C, 4x UxART
- 1x USB 2.0 FS, 1x USB-C PD3.0 (+PHY)
- 1x CAN-FD
- 2x PS half duplex, SAI

Timers
- 5x 16-bit timers
- 2x 16-bit basic timer
- 2x 16-bit advanced motor control timers
- 1x 32-bit timer
- 1x 16-bit LP timer

Accelerators
- ART Accelerator™
- 10-Kbyte CCM-SRAM
- Math Accelerators
  - Cordic (trigo...)
  - Filtering

Analog
- 2x 12-bit ADC
- 4x Comparators
- 4x DAC (2x buff + 2x non-buff)
- 3x Op-Amp (PGA)
- 1x temperature sensor

- 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
Portfolio extended to support budget applications efficiently

More memory and pin counts

<table>
<thead>
<tr>
<th>Flash memory (bytes)</th>
<th>32-pin LQFP</th>
<th>48-pin LQFP</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>

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-DPOW1*
- B-G431B-ESC1*

Available now from distributor stocks
* Available in distributor stocks from Q3-2019
STM32G4 Software Tools

Complete support of Arm Cortex-M ecosystem

**STM32CubeMX**
- Configure and generate Code
- Conflicts solver

**IDEs**
- **Compile and Debug**
  - 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
## 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

Large portfolio available from NOW!
32..512KB Flash memory
32..128-pin packages
Backup Slides