STM32 revolutionizing motor control solutions

Otis Chan
STMicroelectronics
Agenda

1. STM32 for motor control
2. Motor control ecosystem
STM32 for motor control
# STM32 portfolio

## MPU

<table>
<thead>
<tr>
<th>Model</th>
<th>Enumerated Name</th>
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<th>Clock Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>STM32F2</td>
<td>Up to 398 CoreMark</td>
<td>120 MHz Cortex-M3</td>
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<td>STM32F4</td>
<td>Up to 608 CoreMark</td>
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<td>STM32H5</td>
<td>Up to 1023 CoreMark</td>
<td>250 MHz Cortex-M33</td>
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<td>STM32F7</td>
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<td>STM32N6</td>
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## High Perf MCUs

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<td>STM32G0</td>
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<td>STM32F1</td>
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<td>STM32WBA</td>
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## Mainstream MCUs

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## Ultra-low power MCUs

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## Wireless MCUs

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## Latest product generation

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## Preannouncement

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## Mixed-signal MCUs

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## New series introduced in 2023

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## Radio coprocessor only

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## MCU with neural processing unit

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## Dual 1.5 GHz Cortex-A35

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## 400 MHz Cortex-M33

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Flagship STM32 motor control MCUs

- **STM32F0x/G0x**: Cortex-M0/M0+, Cost-effective MCUs
  - 64 MHz (59 DMIPS)
  - 16 KB
  - 32 KB
  - 512 KB

- **STM32F30x/G4xx**: Cortex-M4, Mixed-signal MCUs
  - 170 MHz (213 DMIPS)
  - 32 KB
  - 32 KB
  - 512 KB

- **STM32H7xx**: Dual core (C-M7 + C-M4), Single (C-M7), High-performance MCUs
  - 480+240 MHz (1027+300 DMIPS)
  - 550 MHz (1327 DMIPS)
  - 640 MHz (1327+167 DMIPS)
  - 2 MB

Flash Memory

- 16 KB
- 32 KB
- 512 KB
- 256 KB
- 512 KB
- 2 MB
STM32G4 mixed-signal MCUs

Motor control pack
- Full feature for motor control and analog
  - P-NUCLEO-IHM03

General purpose / motor control
- STM32G4x1
  - 32 KB memory
  - 32-pin pin count
- STM32G4x3
  - 512 KB memory
  - 128-pin pin count

Analog
- Arm Cortex-M4 CPU @ 170 MHz
- Mathematical accelerator (Cordic)
- Advanced Motor control timers
- Fast comparators
- 4 MspS ADC-12-bit + HW oversampling
- Op amp with built-in gain (PGA)
- DAC-12-bit
- 1% RC accuracy
  (UART communication w/o external Xtal)

Motor Control
- Home appliances, E-bikes, air conditioning,
- Industrial equipment

Industrial devices
- 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

STM32G4x1
- 32 KB memory
- 32-pin pin count
STM32G4x3
- 512 KB memory
- 128-pin pin count
STM32F3x
- 32-pin pin count
MC-SDK
motor control ecosystem
STM32 motor control ecosystem

Motor Control Suite (ST-MC-SUITE)
- Online tool that provides easy access to motor-control resources in the MCU ecosystem - for STM32, STSPIN32, and STM8 MCUs.

Motor Control SW Development Kit (X-CUBE-MCSDK)
- Motor Control FW lib: full feature library
- Motor Control Workbench: Graphical (GUI) configurator/monitor
- For STM32, STSPIN32 MCUs.

STM32Cube
- Embedded software bricks
- Most of STM32 series supported (STM32G4 = Motor Ctrl flagship)

Motor Control Profiler
- Automatic detection of key parameters (Rs, Ls, Ke)
- Zero equipment required
- For STM32 MCUs.

Visit the STM32 Motor control web page:
stm32-motor-control-ecosystem.html
From hardware to final motor control application

1. Hardware setup
2. Motor characterization
3. Motor Control Workbench
4. Project configuration
5. Motor drive tuning
6. Final application development

User code

```c
#include "MC.h"
{
    CMCI oMCI = GetMCI(M1);
    MCI_ExecSpeedRamp(oMCI, final speed, ramp duration);
    MCI_StartMotor(oMCI);
}
```

Use ST-MC-SUITE online tool to identify your most appropriate hardware board
What’s New in the MC-SDKv6.x?

**FOC and 6-Step** supported from the GUI Motor Control Workbench (MCWB)

**More autonomy for designers**: Designers can describe their own hardware boards and configure its features with the MCWB

**More comprehensive graphical peripheral configuration**

Firmware configuration options match the hardware capabilities (no impossible case)

Support for all series supported by v5.4+5.Y (except F1)

Introduce support for **C0** and **H5**

➔ Visit the STM32 Motor Control Wiki!
Target applications:

- In applications where:
  - Dynamic performance requirements are moderate
  - Quietness of sinusoidal current control (vs six steps drive) is valuable
  - Extended speed range is required
- Particularly suitable for pumps, fans, and compressors

**FOC target application and benefit**

- More silent
- Lower torque ripple
- Extended speed range easier to be achieved
MC Workbench in MC SDK V6.X

- Enhanced for a better usage experience
  - New and nicer look GUI & feel
  - HAL/LL version usage selection
  - IDE version usage selection
  - Additional settings for code generation
  - Automatic migration from older version

- STM32CubeMX should already be installed

---

1. ST MC Workbench V6.X
2. Project generation
3. Project folder structure, including initialization code and IDE project files, are automatically generated (IP initialization generated by STM32CubeMX)
STM32 MC Workbench global view
• When the hardware is ready, how can users identify the motor when they don’t know the motor parameters?
• By using the Motor Profiler!
  • Follow the instructions in following slide.
Motor Profiler parameter detection step

Motor stopped
Rs measurement
Ls measurement
Current regulators set-up

Open loop
- Ke measurement
- Sensorless state observer set-up
- Switch over

Closed loop
- Friction coefficient measurement
- Moment of inertia measurement
- Speed regulator set-up

10 sec
5 sec
45 sec
Control, monitor, tune, and debug your real-time applications

**Real time monitoring**: each sample can be plotted and recorded

**GUI customization**: any developer can easily customize Motor Pilot GUI to fit application needs

Most MCU registers can be monitored
Motor pilot, your digital oscilloscope

- **Display the version of the embedded firmware**
- **Show current status and errors**
- **Troubleshooting**
- **Motor start**
- **Motor stop**
- **Click on the stop ramp to stop it before the end**
- **Click on advanced configuration**
- **Set target speed, duration, and tap to apply ramp**
- **Drag the knob to set the speed**
- **Display speed, current, and other information**
Helping motor control designers select the best solution for their design

For the highest level of design flexibility, ST offers all products to address a broad range of low- and high-voltage applications, according to the most common application partitioning.

Solution 1
“Discrete”

STM8/32 (MCU) + STDRIVE (Gate driver) + STPOWER (MOSFET)

Solution 2
“Power integration”

STM8/32 (MCU) + STSPIN / PWD-SPIN (Gate drivers + MOSFET)
Flexible motor control platforms

STM32 PMSM FOC SDK (Firmware library)

Flexible motor control platform
- Based on ST MC connector
  - Control stages
  - Power stages

Complete motor control drives

STM32 ODE: Nucleo + X-NUCLEO

Motor control kit

Board list
B-G431B-ESC1 discovery kit

Electronic speed controller

- FOC and 6-step algorithms for BLDC/PMSM
- Designed for drones with up to 6S LiPo
- Output peak motor current 40A

- STripFET F7 power MOSFETs – 60 V, 120 A
- Arm(a) Cortex®-M4 32-bit STM32G431CB MCU
<table>
<thead>
<tr>
<th>Title</th>
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<tbody>
<tr>
<td>AN5143</td>
<td>Application note</td>
<td>How to migrate motor control application software from SDK v4.3 to SDK v5.x</td>
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<tr>
<td>AN5166</td>
<td>Application note</td>
<td>Guidelines for control and customization of power boards with STM32 MC SDK v5.0</td>
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<td>User manual</td>
<td>Getting started with STM32 motor control SDK v5.0</td>
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Our technology starts with You

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