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**Overview of the STM32F103xx  
ACIM and PMSM motor control software libraries release 2.0**

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**Introduction**

The purpose of this technical note is to provide an overview of the main features and performance metrics of the STM32F103xx motor control firmware libraries release 2.0.

For the complete documentation, please refer to the two following user manuals:

- UM0483: *STM32F103xx AC induction motor IFOC software library V2.0*
- UM0492: *STM32F103xx permanent-magnet synchronous motor FOC software library V2.0*

These documents are available for free upon request to your nearest STMicroelectronics sales office or distributor. For a complete list of ST offices and distributors, refer to the ST website [www.st.com](http://www.st.com).

**New features in this motor control firmware library package  
release 2.0**

- patented single, common DC link shunt-resistor current-sampling method
- optimized IPMSM (internal permanent-magnet synchronous motor) maximum-torque-per-ampere strategy
- redesigned closed-loop flux weakening algorithm for PMSMs
- optional rotor repositioning before each motor startup in the PMSM sensorless mode
- optional feed-forward current regulation for PMSM
- more robust hall-sensor module for PMSM
- redesigned PID regulation module
- maximum-modulation-index configuration tool for the single-shunt and three-shunt current-sampling methods
- supports all members of the STM32F103xx performance line family
- workspaces for IAR EWARM 5.20, KEIL RVMDK 3.22, Green Hills MULTI 5.03
- Companion parameter file generation tool for PMSM (FOCGUI)

# 1 Presentation of the STM32F103xx AC induction motor IFOC software library V2.0

The UM0483 user manual describes the AC induction motor IFOC software library, an indirect field oriented control (IFOC) firmware library for 3-phase induction motors developed for the STM32F103xx microcontrollers.

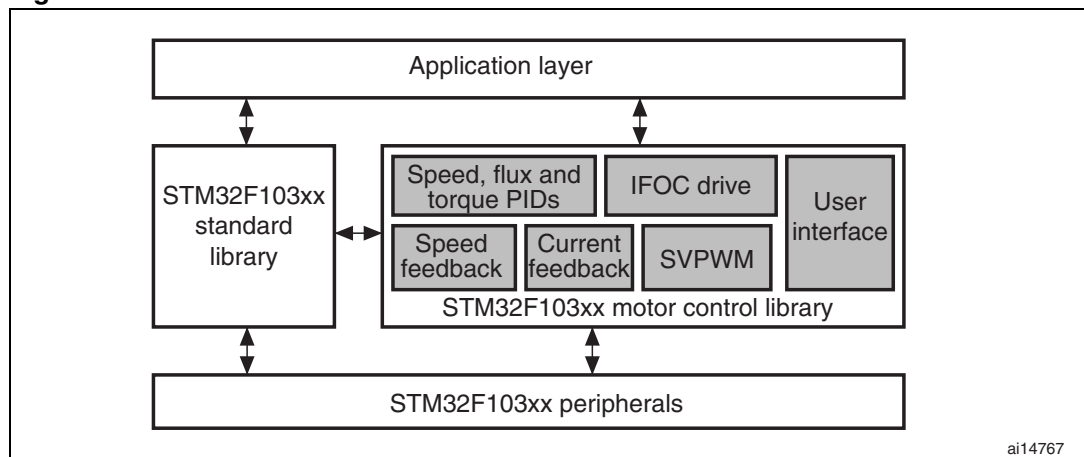
These 32-bit, ARM Cortex™-M3 cored ST microcontrollers (STM32F103xx) come with a set of peripherals which makes it suitable for performing both permanent magnet and AC induction motors FOC. In particular, this manual describes the STM32F103xx software library developed to control AC induction motors equipped with an encoder or tachogenerator, in both torque and speed control modes. The control of a permanent magnet (PM) motor in sinewave mode with encoder/hall sensors or sensorless is described in the UM0492 user manual.

The AC IM IFOC software library is made of several C modules and is fitted out with IAR EWARM 5.20, KEIL RealView MDK 3.22a and Green Hills MULTI 5.03 workspaces. It is used to quickly evaluate both the MCU and the available tools. In addition, when used together with the STM32F103xx motor control starter kit (STM3210B-MCKIT) and an AC induction motor, a motor can be made to run in a very short time. It also eliminates the need for time-consuming development of IFOC and speed regulation algorithms by providing ready-to-use functions that let the user concentrate on the application layer.

A prerequisite for using this library is basic knowledge of C programming, AC motor drives and power inverter hardware. In-depth know-how of STM32F103xx functions is only required for customizing existing modules and for adding new ones for a complete application development.

Figure 2 shows the architecture of the firmware. It uses the STM32F103xx standard library extensively but it also acts directly on hardware peripherals when optimizations in terms of execution speed or code size are required.

**Figure 1. ACIM firmware architecture**



## AC IM IFOC software library V2.0 features (CPU running at 72 MHz)

- Supported speed feedback:
  - Tachogenerator
  - Quadrature incremental encoder
- Current sampling method:
  - 2 isolated current sensors (ICS)
  - 3 shunt resistors placed on the bottom of the three inverter legs
  - single, common DC link shunt resistor
- DAC functionality for tracing the most important software variables
- Current regulation for torque and flux control:
  - PID sampling frequency adjustable up to the PWM frequency
- Speed control mode for speed regulation
- Torque control mode for torque regulation
- Field weakening
- 16-bit space vector PWM generation frequencies:
  - PWM frequency can be easily adjusted
  - Centered PWM pattern type
  - 11 bits resolution at 17.6 kHz
- Free C source code and spreadsheet for look-up table generation
- CPU load below 21% (IFOC algorithm refresh frequency 10 kHz)
- Code size 11.5 KB (three shunt resistors for current reading, tachogenerator for speed feedback) + 12.6 KB for LCD/joystick management

*Note: These figures are for information only; this software library may be subject to changes depending on the final application and peripheral resources. Note that it was built using robustness-oriented structures, thus preventing the speed or code size from being fully optimized.*

### Related documents

Available on [www.st.com](http://www.st.com):

- STM32F103xx datasheet
- 'ARM®-based 32-bit MCU STM32F101xx and STM32F103xx, firmware library' user manual
- 'STM32F103xx Flash programming' manual

Available on [www.arm.com](http://www.arm.com):

- Cortex-M3 Technical Reference Manual

## 2 Presentation of the STM32F103xx permanent-magnet synchronous motor FOC software library V2.0

The UM0492 user manual describes the permanent magnet synchronous motor (PMSM) FOC software library, a field oriented control (FOC) firmware library for 3-phase permanent-magnet motors developed for the STM32F103xx microcontrollers.

These 32-bit, ARM Cortex™-M3 cored ST microcontrollers (STM32F103xx) come with a set of peripherals that makes it suitable for performing both permanent-magnet and AC induction motor FOC. In particular, this manual describes the STM32F103xx software library developed to control sine-wave driven permanent-magnet motors in both torque and speed control mode. These motors may be equipped with an encoder, with three Hall sensors or they may be sensorless. The control of an AC induction motor equipped with encoder or tachogenerator is described in the UM0483 user manual.

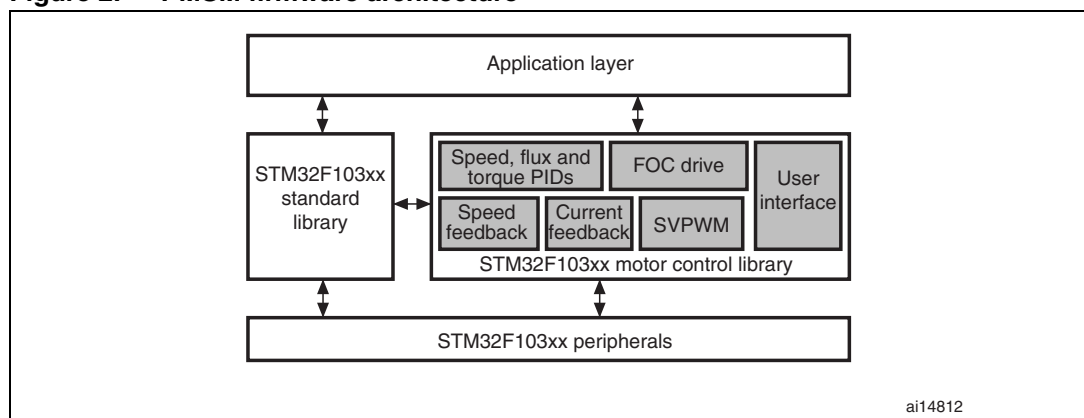
The PMSM FOC library is made of several C modules, and is fitted out with IAR EWARM 5.20, KEIL RealView MDK 3.22a and Green Hills MULTI 5.03 workspaces. It is used to quickly evaluate both the MCU and the available tools. In addition, when used together with the STM32F103xx motor control starter kit (STM3210B-MCKIT) and PM motor, a motor can be made to run in a very short time. It also eliminates the need for time-consuming development of FOC and speed regulation algorithms by providing ready-to-use functions that let the user concentrate on the application layer. Moreover, it is possible to get rid of any speed sensor thanks to the sensorless algorithm for rotor position reconstruction.

A prerequisite for using this library is basic knowledge of C programming, PM motor drives and power inverter hardware. In-depth know-how of STM32F103xx functions is only required for customizing existing modules and for adding new ones for a complete application development.

Users are assisted in customizing their PMSM application firmware by a parameter file generation tool (FOCGUI) which, starting from the system parameters, automatically generates all that is needed by the motor control firmware library to quickly run the motor, saving time and easing the development phase. This tool can be downloaded from: <http://www.st.com/mcu/>.

Figure 2 shows the architecture of the firmware. It uses the STM32F103xx standard library extensively but it also acts directly on hardware peripherals when optimizations in terms of execution speed or code size are required.

Figure 2. PMSM firmware architecture



## PMSM FOC software library V2.0 features (CPU running at 72 MHz)

- Supported speed feedbacks:
  - Sensorless
  - 60° or 120° displaced Hall sensors
  - Quadrature incremental encoder
- Current-sampling method:
  - 2 isolated current sensors (ICS)
  - single, common DC link shunt resistor
  - 3 shunt resistors placed on the bottom of the three inverter lags
- optimized IPMSM & SM-PMSM drive
- field weakening
- feed-forward, high-performance current regulation
- DAC functionality for tracing the most important software variables
- Brake resistor management
- Speed control mode for speed regulation
- Torque control mode for torque regulation
- 16-bit space vector
  - PWM frequency can be easily adjusted
  - Centered PWM pattern type
  - 11-bit resolution at 17.6 kHz
- Rules for the “a priori” determination of all the parameters necessary for firmware customization
- CPU load below 22% in the 3-shunt/sensorless configuration (10 kHz FOC sampling rate)
- Code size in 3-shunt/sensorless configuration is about 12.5 Kbytes plus 11.5 Kbytes for LCD/joystick management

### 3 Revision history

Table 1. Document revision history

Date	Revision	Changes
31-Jan-2008	1	Initial release.
04-Sep-2008	2	Motor control firmware library package upgraded (release 2.0). <i>New features in this motor control firmware library package release 2.0</i> added. <i>AC IM IFOC software library V2.0 features (CPU running at 72 MHz)</i> updated to UM0483 rev. 2. <i>PMSM FOC software library V2.0 features (CPU running at 72 MHz)</i> updated to UM0492 rev. 2.
16-Sep-2008	3	Library release number corrected in <i>Section 2</i> .

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