STM32 MCU family

32-bit Flash microcontrollers powered by ARM® Cortex™-M3

STM32 Releasing your **creativity**

May 2008

Welcome to the world of STM32

Releasing your creativity

The STM32 family of 32-bit Flash microcontrollers is based on the breakthrough ARM Cortex-M3 core – a core specifically developed for embedded applications that require a combination of high-performance, real-time, low-power and low-cost operation. The STM32 family benefits from the Cortex-M3 architectural enhancements (including the Thumb-2® instruction set) that deliver improved performance combined with better code density, and a tightly coupled nested vectored interrupt controller that significantly speeds response to interrupts, all combined with industry-leading power consumption. STMicroelectronics was a lead partner in developing the Cortex-M3 core and is now the first leading MCU supplier to introduce a product family based on the core.

The STM32 family is built to offer new degrees of freedom to MCU users. It offers a complete 32-bit product range that combines high-performance, real-time, low-power and low-voltage operation, while maintaining full integration and ease of development.

It eases migration from the 16-bit world thanks to its high level of features integration, its easy-to-use architecture, its low-power capability and cost-effectiveness.

This new family will enable you to create new applications, and design in the innovations you have been long dreaming about.

| The right core	The right choice

The right core

The STM32 is built around the industry-standard ARM 32-bit RISC architecture. The Cortex-M3 is the latest core from ARM.

The Cortex-M3 core targets the microcontroller and embedded markets. The advanced architectural features of the Cortex-M3 processor reduce memory size while delivering industry-leading performance in a small, power-efficient RISC core. It thus provides an ideal platform for the migration of many different applications around the world from legacy devices to the 32-bit microcontroller world.
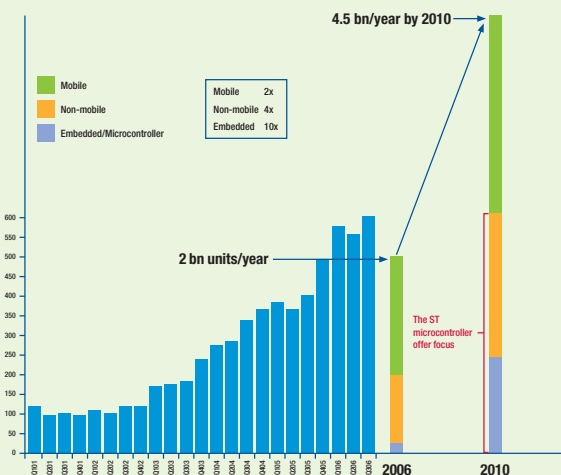
The right choice

The world of STM32
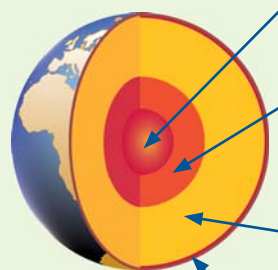
Cortex-M3 core
- Open world of ARM
- Standard core

Peripherals
- High performance and low power
- High level of integration
- Innovate in development

Product range
- Family fully pin-to-pin, peripheral and software compatible
- Rationalize your development

Tools and software
- Best ecosystem of software and tools

ARM: driving momentum

4.5 bn/year by 2010

Mobile	2x
Non-mobile	4x
Embedded	10x

- Mobile
- Non-mobile
- Embedded/Microcontroller

2 bn units/year

The ST microcontroller offer focus

2006   2010

The STM32 family gives you more performance and features without compromising power and cost.

As a result:
1. *You access the open world of ARM technology with a standard core and the best ecosystem of software and tools*
2. *You rationalize your development, because the same family fits many platforms*
3. *You innovate in your projects with the latest software technology (such as RTOS), and by rethinking your hardware and software partitioning to bring breakthrough improvements in your applications*

The STM32 key benefits

- Leading-edge architecture with the latest Cortex-M3 core from ARM
- Excellent real-time behaviour
- Outstanding power efficiency
- Superior and innovative peripherals
- Maximum integration
- Easy development, fast time to market

STM32, the optimal platform choice

The STM32 is an optimal choice to support many applications with the same platform:

- From reduced memory and pin requirements to larger needs
- From performance demanding to battery operated
- From simple cost-sensitive to complex high-value

The total pin-to-pin, peripheral and software compatibility across the family gives you full flexibility across 46 devices.
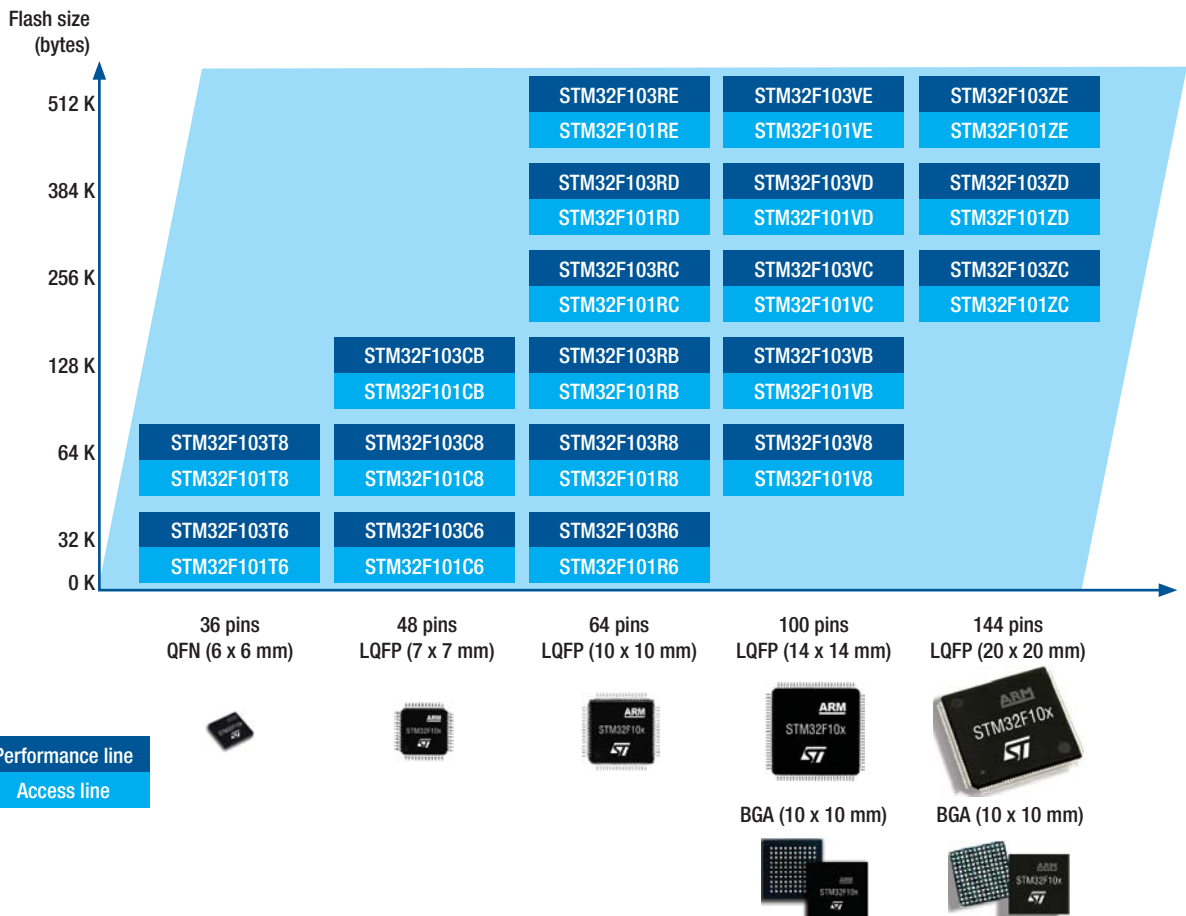
You can upgrade to a higher or downgrade to a lower memory size, or use different packages without changing your initial layout or software.

72 MHz Cortex-M3 CPU – wide selection of devices:

- 6-Kbyte to 64-Kbyte SRAM
- Two lines: Performance and Access
- Pin-to-pin, software and peripheral compatibility across family
- 2.0 to 3.6 V power supply / 5 V tolerant I/Os
- -40 to +85 °C or up to 105 °C operating temperature range

STM32F10x portfolio

46 fully compatible devices

Flash size (bytes)

	36 pins QFN (6 x 6 mm)	48 pins LQFP (7 x 7 mm)	64 pins LQFP (10 x 10 mm)	100 pins LQFP (14 x 14 mm)	144 pins LQFP (20 x 20 mm)
512 K			STM32F103RE / STM32F101RE	STM32F103VE / STM32F101VE	STM32F103ZE / STM32F101ZE
384 K			STM32F103RD / STM32F101RD	STM32F103VD / STM32F101VD	STM32F103ZD / STM32F101ZD
256 K			STM32F103RC / STM32F101RC	STM32F103VC / STM32F101VC	STM32F103ZC / STM32F101ZC
128 K		STM32F103CB / STM32F101CB	STM32F103RB / STM32F101RB	STM32F103VB / STM32F101VB	
64 K	STM32F103T8 / STM32F101T8	STM32F103C8 / STM32F101C8	STM32F103R8 / STM32F101R8	STM32F103V8 / STM32F101V8	
32 K	STM32F103T6 / STM32F101T6	STM32F103C6 / STM32F101C6	STM32F103R6 / STM32F101R6		
0 K					

BGA (10 x 10 mm)   BGA (10 x 10 mm)

- Performance line
- Access line

Applications

Industrial:
- PLC
- Inverters
- Printers, scanners
- Industrial networking

Building and security:
- Alarm systems
- Video intercom
- HVAC

Low power:
- Glucose meters
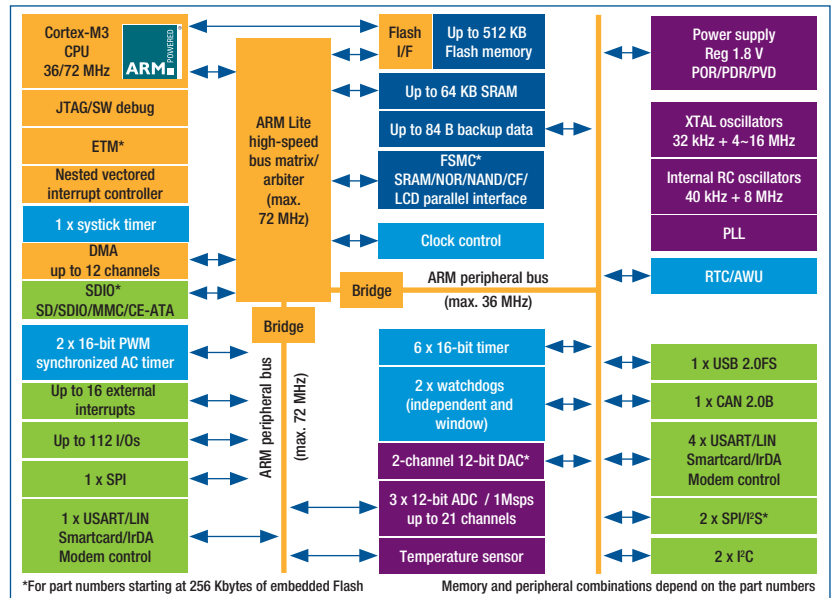- Power meters
- Battery operated applications

Appliances:
- Motor drive
- Application control

Consumer:
- PC peripherals, gaming
- Digital camera, GPS platforms

STM32F10x block diagram

Cortex-M3 CPU 36/72 MHz		Flash I/F	Up to 512 KB Flash memory
JTAG/SW debug			Up to 64 KB SRAM
ETM*			Up to 84 B backup data
Nested vectored interrupt controller			FSMC* SRAM/NOR/NAND/CF/ LCD parallel interface
1 x systick timer			Clock control

ARM Lite high-speed bus matrix/ arbiter (max. 72 MHz)

ARM peripheral bus (max. 36 MHz)

Power supply Reg 1.8 V POR/PDR/PVD

XTAL oscillators 32 kHz + 4~16 MHz

Internal RC oscillators 40 kHz + 8 MHz

PLL

RTC/AWU

DMA up to 12 channels

SDIO* SD/SDIO/MMC/CE-ATA

2 x 16-bit PWM synchronized AC timer

Up to 16 external interrupts

Up to 112 I/Os

1 x SPI

1 x USART/LIN Smartcard/IrDA Modem control

Bridge

Bridge

ARM peripheral bus (max. 72 MHz)

6 x 16-bit timer

2 x watchdogs (independent and window)

2-channel 12-bit DAC*

3 x 12-bit ADC / 1Msps up to 21 channels

Temperature sensor

1 x USB 2.0FS

1 x CAN 2.0B

4 x USART/LIN Smartcard/IrDA Modem control

2 x SPI/I²S*

2 x I²C

*For part numbers starting at 256 Kbytes of embedded Flash   Memory and peripheral combinations depend on the part numbers

AWU:	Auto wake-up capability with RTC alarm	IrDA:	Infrared Data Association
CAN:	Controller area network	I²S:	Inter-IC sound
CF:	CompactFlash	LIN:	Local interconnect network
DMA:	Direct memory access	MMC:	MultiMediaCard
ETM:	Embedded Trace Macrocell	PDR:	Power-down reset
FSMC:	Flexible static memory controller	POR:	Power-on reset

PVD:	Programmable voltage detector
RTC:	Real-time clock
SDIO:	Secure digital input output
SD:	Secure digital
USART:	Universal sync/async receiver transmitter

STM32, more choice with two complete lines

The Performance line, STM32F103, operates at 72 MHz, with more on-chip RAM and peripherals. The Access line, STM32F101, operates at 36 MHz. Both lines are pin-to-pin and software-compatible, and offer the same embedded Flash options.

The Performance line takes the 32-bit MCU world to new levels of performance and energy efficiency.

With its Cortex-M3 core at 72 MHz, it is able to perform high-end computation. Its peripheral set brings superior control and connectivity.

The Access line is the entry point of the STM32 family. It has the power of the 32-bit MCU but at a 16-bit MCU cost. Its peripheral set offers excellent connectivity and control.

STM32F10x: first two product lines

Both lines include:

Up to 512 Kbyte Flash
Multiple communications peripherals USART, SPI, I²C
Multiple 16-bit timers
2-channel 12-bit DAC*
ETM*
FSMC*
Main oscillator 4-16 MHz
Internal 8 MHz and 40 kHz RC oscillators
Real-time clock
2 x watchdogs
Reset circuitry
Up to 12-channel DMA
80% GPIO ratio

Performance line STM32F103

72 MHz CPU	Up to 64 Kbyte SRAM	2/3 x 12-bit ADC (1 µs) Temperature sensor	USB 2.0 FS	CAN 2.0 B	1/2 PWM timer	SDIO*	I²S*

+

Access line STM32F101

| 36 MHz CPU	Up to 48 Kbyte SRAM	1 x 12-bit ADC (1 µs) Temperature sensor				

*For part numbers starting at 256 Kbytes of embedded Flash

STM32 key benefits

Leading-edge architecture with Cortex-M3 core

- Harvard architecture
- 1.25 DMIPS/MHz and 0.19 mW/MHz
- Thumb-2 instruction set brings 32-bit performance with 16-bit code density
- Single cycle multiply and hardware division
- Embedded, fast interrupt controller is now inside the core allowing:
  - Excellent real-time behaviour
  - Low latency down to six CPU cycles inter-interrupt
  - Six CPU cycles wake-up time from low-power mode
- Up to 35% faster and up to 45% less code than ARM7TDMI®

Cortex-M3 performance versus ARM7TDMI
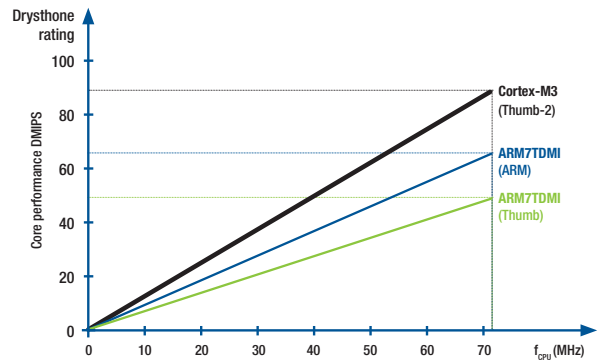
Cortex-M3 interrupt versus ARM7TDMI
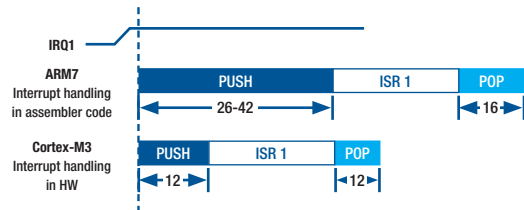
Outstanding power efficiency

High performance does not mean high power consumption. We have taken special care to address three main energy requirements driven by the market:

- High dynamic power efficiency in running mode
- Extremely low power when the application is in standby
- Low-voltage capability for direct battery operation

In run mode, executing from Flash at full 72 MHz CPU speed, the STM32 has a current consumption as low as 27 mA.

STM32F10x: Low power

In standby mode, current consumption is as low as 2 µA typical, with reset circuitry active. Finally, its 2.0 V to 3.6 V power supply enables its use for battery operated applications.

The STM32 has three different low-power modes and a versatile clocking scheme so that users can optimize power consumption versus performance.

The STM32 also embeds a real-time clock (RTC) running either from a 32 kHz quartz oscillator or an internal RC oscillator. The RTC has a separate power domain, with an embedded switchover to run either from a dedicated coin cell battery or from the main supply. Its typical current consumption is 1.4 µA at 3.3 V. It embeds up to 84 bytes for data backup. Start-up time from low-power modes is lower than 6 µs typical from stop mode, and 50 µs typical from standby mode and reset.
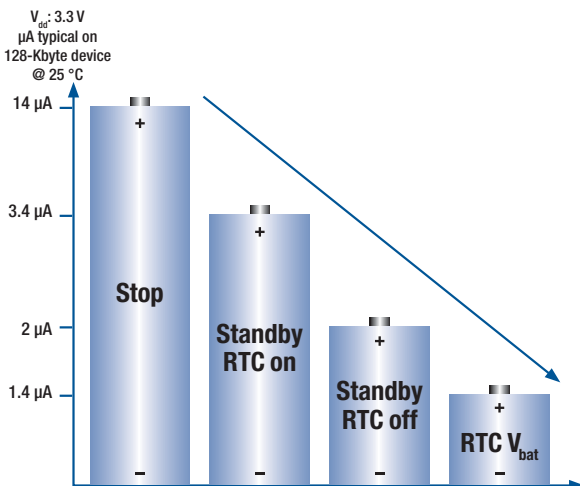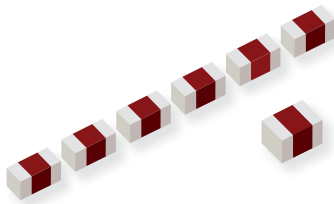
- Low voltage **2.0 V to 3.6 V** operation
- Down to 27 mA in run mode from Flash at 72 MHz
- Startup time from stop **< 6 µs**
  Startup time from standby **50 µs**
- **Reset circuitry always active**

High level of integration

- Built-in supervisor reduces need for external components:
  - Power-on reset, low-voltage detect, brown-out detect, watchdog timer with independent clock
- One main crystal drives entire system:
  - Inexpensive 4-16 MHz crystal drives CPU, USB and all peripherals
  - Embedded PLL generates multiple frequencies
  - Optional 32 kHz crystal for RTC
- Embedded factory trimmed 8 MHz RC oscillator can be used as main clock
- Additional low-frequency RC oscillator for RTC or watchdog
- Only 7 external passive components required for base system on LQFP100 package

7 power capacitors only!

Superior and innovative peripherals

The need for speed	
USB	12 Mbit/s
USART	up to 4.5 Mbit/s
SPI	18 MHz master and slave
I²C	400 kHz
GPIO	18 MHz maximum toggle
PWM timer	72 MHz clock input
SDIO	Up to 48 MHz
I2S	From 8 kHz to 48 kHz sampling frequencies

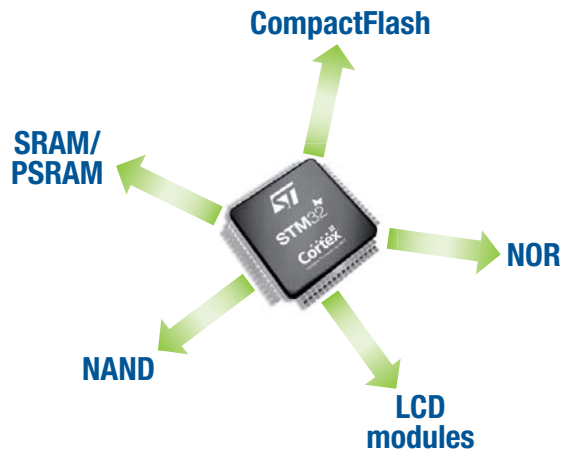| The need for analog	
ADC	12-bit, 1 µs conversion time
DAC	2-channel, 12-bit

Flexible static memory controller (FSMC)

The flexible static memory controller offers:
- 4 independent banks to support external memory with frequency up to 36 MHz when system is at 72 MHz
- CompactFlash, SRAM, PSRAM, NOR and NAND memories support
- Programmable timings to support a wide range of devices
- Code execution from external memory
- Parallel interface to LCD controllers, Intel 8080 / Motorola 6800 modes support

CompactFlash

SRAM/ PSRAM

NOR
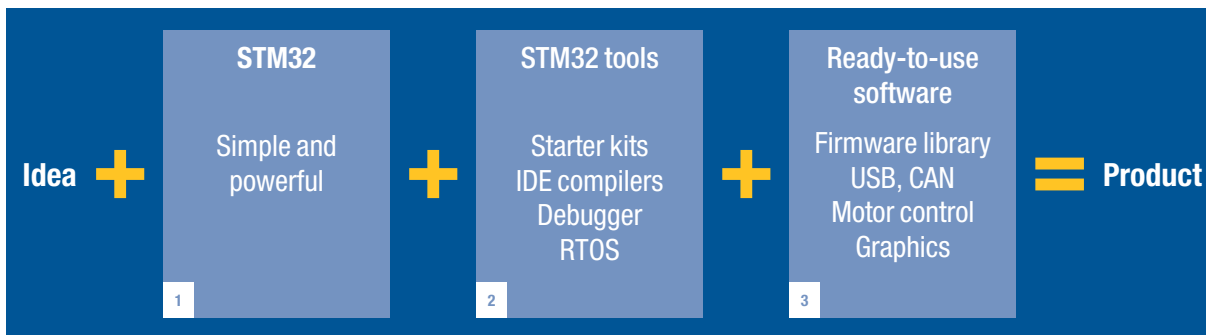
NAND

LCD modules

Motor control

- The STM32 Performance line embeds features that are perfectly suited to three-phase brushless motor control:
  - Powerful Cortex-M3 core
  - 6 PWM advanced control timers with embedded dead-time generation
  - Numerous PWM outputs allowing multiple DC-brush, stepper or universal motor drives
  - Dual sample and hold ADC, 12-bit resolution, 1 µs conversion time
- Free motor control firmware libraries supporting AC induction motor (sensored) and PMSM motor (sensorless, Hall-sensor or encoder) vector control

- Less than 21 µs for sensorless vector control loop
- Class B compliancy with the EN/IEC60335-1 norm:
  - Pre-certified full set of self-test routines
- Run your motor in just a few steps:
  - STM3210B-MCKIT full developer kit for vector drives
- In the Performance line, for devices starting at 256 Kbytes of Flash, two advanced control PWM timers and three ADCs are on board for dual motor control, triple sample and hold capabilities.

STM32 easy development, fast time to market

From ideas to reality. As easy as 1, 2, 3

| Idea + | **STM32**

Simple and powerful

1 | + | **STM32 tools**

Starter kits
IDE compilers
Debugger
RTOS

2 | + | **Ready-to-use software**

Firmware library
USB, CAN
Motor control
Graphics

3 | = **Product** |

STM32 firmware library

The STM32 firmware library provides easy access to all features of the standard device peripherals of the STM32. This free software package provides drivers for all standard device features and peripherals, from GPIO and timers to CAN, I²C, FSMC, I²S, SDIO, DAC, SPI, UART, ADC and more.
The fully documented and tested C source code requires only basic knowledge of C programming, is compatible with any C compiler for ARM-core-based microcontrollers, and is MISRA C-compliant (2004 rules).
The STM32 library shares the same APIs with the STR7 and STR9 libraries.

USB developer kit

The USB developer kit facilitates USB implementation in a full range of applications by providing a complete,
USB-certified firmware package that allows developers to painlessly develop any flavor of USB firmware including:
- Control transfer with generic device management tasks
- Interrupt transfer with HID mouse/joystick demo
- Bulk transfer with mass storage demo
- Isochronous transfer with voice speaker/microphone demo

The kit implements device firmware updates (DFU) on USB, and Virtual COM (CDC class) for emulation of an RS232 interface on USB.
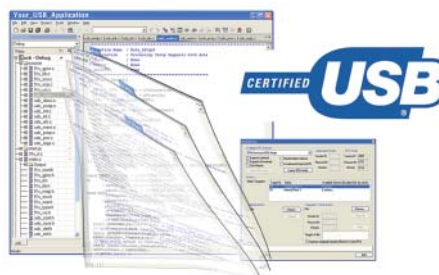
STM32 motor control firmware library for vector drive

Optimized and documented C firmware libraries for control of both PMSM and AC induction brushless motors in vector mode (FOC) are provided for free upon request.
These modular libraries support both types of motors in standalone mode using ST hardware. The source files are provided free of charge and are MISRA C (latest rules) compliant, which helps for compliancy with IEC 60730.

STM32 encryption library - AES-ECB 128 encryption for STM32F103x

Optimized crypto library for the STM32 32-bit microcontroller, mainly for data-security needs. The AES-ECB 128-bit symmetric key algorithm coupled with the STM32 Cortex-M3 provides great performance with strong data protection. The AES-ECB 128-bit benchmark for the STM32 is available upon request with 16-, 32-, 64- and 128-byte plaintext for Keil, IAR and Hitex toolchains.

Internet support

The latest news, downloads and documentation for STM32 microcontrollers can be found at: www.st.com/stm32
Here, you will also find:
- A complete selection guide for ST microcontrollers and development tools
- Downloads of free software and documentation
- Microcontroller and application-specific online forums and FAQs

For further information about a specific third-party tool, please visit the website of the relevant third-party tool supplier.

Development tools

A complete range of high-end and low-cost development tools is available, including complete tool solutions, easy-to-use starter kits, and embedded operating systems, all tailored to the STM32.

Third-party development solutions

Choose from a full range of solutions that offer start-to-finish control of application development from a single environment that includes development environment, C/C++ compiler and in-circuit emulator.

Supplier	Description
Altium/Tasking www.tasking.com	EDE development environment, Tasking VX compiler, debugging/programming via JTAG
Green Hills Software www.ghs.com	Multi development environment, GHS C/C++ compiler and Green Hills probe (USB or Ethernet/JTAG)
Hitex www.hitex.com	HiTOP5 development environment, Tasking VX compiler and Tantino (USB/JTAG)
IAR www.iar.com	EWARM development environment, IAR C/C++ compiler and J-Link (USB/JTAG)
iSYSTEM www.isystem.com	WinIdea development environment, ARM, GHS, GNU, IAR, Keil, Tasking compiler and iONE (USB/JTAG)
Keil www.keil.com	RealView MDK with uVision3 software, ARM C/C++ compiler and ULINK (USB/JTAG)
Lauterbach www.lauterbach.com	TRACE32 PowerView development environment, supporting a wide range of C/C++ compilers
Raisonance www.raisonance.com	RIDE development environment with GNU C/C++ compiler and RLink (USB/JTAG)
Rowley www.rowley.co.uk	CrossWorks with CrossStudio software, GNU C/C++ compiler and CrossConnect (JTAG)

For information about compatibility with other tools, refer to the relevant third-party internet site.

Operating systems

A range of portable royalty-free, small-footprint operating systems to meet a variety of application constraints from low cost to high security.

RTOS supplier	RTOS
CMX Systems: www.cmx.com	CMX-RTX
Express Logic: www.rtos.com	ThreadX
FreeRTOS: www.FreeRTOS.org	FreeRTOS
IAR: www.iar.com	PowerPac
Keil: www.keil.com	ARTX-ARM
Micrium: www.micrium.com	µC/OS-II
Quadros Systems: www.quadros.com	RTXC Quadros
Segger: www.segger.com	embOS, emWIN

Low-cost and application-specific starter kits

Play, explore and develop applications on the STM32 Primer with Raisonance toolset, free demos and an online community at **www.stm32circle**.com to stimulate creative designs.

Evaluate STM32 performance in real time, with the innovative STM32-PerformanceStick and DashBoard performance evaluation GUI, sample applications and unlimited Hitex toolset.

Part number	Description
STM3210B-PRIMER	Raisonance STM32 Primer with RIDE (debug up to 32 Kbytes of code), GNU C/C++ compiler, and a fun, stimulating learning and development platform with MEMS-based controls and integrated RLink (USB/JTAG)
STM3210B-PFSTICK	STM32-PerformanceStick with integrated debugging/programming via USB, unlimited Hitex HiTOP5 and Tasking VX compiler and DashBoard GUI
STM3210B-SK/HIT	Hitex kit with unlimited HiTOP5, Tasking VX compiler, STM32-PerformanceStick with integrated debugging/programming via USB, extension I/O board with peripheral evaluation features, DashBoard GUI
STM3210B-SK/IAR	IAR Embedded Workbench for ARM (for up to 32 Kbytes of code), IAR C/C++ compiler, J-Link (USB/JTAG), evaluation board
STM3210B-SK/KEIL	Keil RealView MDK with uVision 3 (for up to 16 Kbytes of code), ARM C/C++ compiler, ULINK (USB/JTAG), evaluation board
STM3210B-SK/RAIS	Raisonance REva kit with RIDE (debug up to 32 Kbytes of code), GNU C/C++ compiler, modular evaluation hardware with integrated RLink (USB/JTAG)
STM3210B-MCKIT	ST motor-control starter kit with complete sensor and sensorless libraries, evaluation hardware platform for vector drive of three-phase PMSM and induction motors, plus Segger J-Link for host PC interface

Evaluation board STM3210B-EVAL and STM3210E-EVAL

Complete hardware evaluation platform with the STM32F103, implementing the full range of device peripherals and features.

For more information, visit **www.st.com/stm32**

For selected STMicroelectronics sales offices fax:
China +86 21 34054689; France +33 1 55489569; Germany +49 89 4605454; Italy +39 02 8250449; Japan +81 3 57838216; Singapore +65 6481 7771; Sweden +46 8 58774411; Switzerland +41 22 9292900; United Kingdom and Eire +44 1628 890391; USA +1 781 861 2678
Full product information at www.st.com

Order code: BRSTM320508

Recycled and chlorine free paper