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Releasing your creativity

STM32 F4 series Cortex™-M4 MCUs

Content

STM32 F4 series

32-bit Flash MCU, 180 MHz/225 DMIPS, with DSP instructions, floating point unit and advanced peripherals

ST is extending its range of target applications with the STM32 F4 series. Based on the Cortex™-M4 core, this series opens the door to the digital signal controller (DSC) market. This extension to our STM32 product portfolio offers devices that are pin-to-pin and software compatible with the STM32 F2 series, but with more performance, DSP capability, a floating point unit, more SRAM, and peripheral improvements such as TFT LCD controller with graphic acceleration, SDRAM, serial audio interface, less than 1 µA RTC and 2.4 MSPS ADCs.
The ARM® Cortex-M4 core features built-in single-cycle multiply-accumulate (MAC) instructions, optimized SIMD and saturated arithmetic instructions.

The adaptive real-time ART Accelerator™ combined with ST's 90 nm technology provides linear performance up to 180 MHz, unleashing the full performance of the core. The Chrom-ART Accelerator™ offers twice as much performance for graphic content creation and manipulation.
These features expand the number of addressable applications in the industrial, consumer and healthcare segments.
The STM32 F4 series includes devices with 512 Kbytes to 2 Mbytes of on-chip Flash memory, and up to 256 Kbytes of SRAM, and 20 communication interfaces.
WLCSP (down to 4.0 x 4.2 mm), LQFP64, LQFP100, LQFP144, LQFP176, LQFP208, UFBGA176 and TFBGA216 packages are available.

KEY APPLICATIONS

- Industrial and medical
  - Control panels with LCD screens for alarm systems, high-end meters, factory automation
  - Medical: respiratory equipment, patient monitors
  - EPOS: scanners, cash registers, tax machines, vending machines, printers
  - Industrial AC servos, general-purpose inverters, solar inverters and robots
  - Surveillance cameras
- Consumer
  - HMI for appliances
  - DAB, car radios and infotainment
  - Home audio, switch boxes, headsets

BLOCK DIAGRAM

Notes:
1. HS requires an external PHY connected to the ULPI interface
2. Crypto/hash processor on STM32F415, STM32F417, STM32F437 and STM32F439
3. With digital filter feature

FEATURES AND BENEFITS

Features	Benefits
High-performance • 180 MHz/225 DMIPS Cortex-M4 with single cycle DSP MAC and floating point unit • CoreMark score: 606 at 180 MHz • CoreMark/MHz: 3.36	• Boosted execution of control algorithms • More features for your applications • Ease of use • Better code efficiency • Faster time to market • Elimination of scaling and saturation • Easier support for meta-language tools
Designed for high performance and ultra-fast data transfers • ART Accelerator™: memory accelerator • Chrom-ART Accelerator™: graphic accelerator (rectangle feeling, rectangle copy with pixel format conversion and blending)	• Performance equivalent to zero-wait execution from Flash • Twice as much performance for graphic content creation and manipulation
• 32-bit, 7-layer AHB bus matrix with 7 masters and 10 slaves including 3 blocks of SRAM • Multi DMA controllers: 2 general-purpose, 1 for USB HS, one for Ethernet	• Concurrent execution and data transfer
• One 4th SRAM block dedicated to the core	• Simplified resource allocation
• Flexible memory interface with SDRAM support: up to 84 MHz, 32-bit parallel	• High bandwidth for external memories • Cost-effective external RAM
Outstanding power efficiency • Ultra-low dynamic power in Run mode: 260 µA/MHz at 180 MHz running CoreMark benchmark from Flash memory (peripherals off) • RTC <1 µA typ in V_{BAT} mode • Down to 100 µA typ in Stop mode (STM32F429/439) • 3.6 V down to 1.7 V[1] V_{DD} • 1.2 V voltage regulator with power scaling capability	• Extra flexibility to reduce power consumption for applications requiring both high-processing and low-power performance when running at low voltage or on a rechargeable battery
Maximum integration Up to 2 Mbytes of on-chip dual bank Flash memory, 256 Kbytes of SRAM, reset circuit, internal RCs, PLLs, ultra-small packages (WLCSP)	• Read while write operations support • More features in space constrained applications • Use of high-level languages: Java, .Net
Superior and innovative peripherals • Connectivity: camera interface, crypto/hash HW processor with AES GCM and CCM support, and SHA-256 • Ethernet MAC10/100 with IEEE 1588 v2 support, 2 USB OTG (one with HS support) • Up to 20 communication interfaces (including 4x USART + 4x UART, 6x SPI, 3x I²C with digital filter, 2x CAN, SDIO) • USART at 11.25 Mbit/s; SPI at 42 Mbit/s	• New possibilities to connect and communicate high-speed data
• Audio: dedicated audio PLL, 2x I²S and 1x SAI with TDM[2] support	• High-quality multi-channel audio support
• LCD TFT controller • Up to SVGA format (800x600) • Up to 24-bit RGB parallel pixel output • 2-layer support with blending	• Support for cost-effective standard displays
• Analog: 2x 12-bit DACs, 3x 12-bit ADCs reaching 7.2 MSPS in interleaved mode • Up to 17 timers: 16 and 32 bits running up to 180 MHz	• More precision thanks to high resolution

FEATURES AND BENEFITS

Features	Benefits
Extensive tools and software solutions	
• Hardware sector protection with execute only access, • various IDE, starter kits, libraries, RTOS and stacks, either open source or provided by ST or 3rd parties, including the ARM CMSIS DSP library optimized for Cortex-M4 instructions	• Software IP protection • A wide choice within the STM32 ecosystem to develop your applications

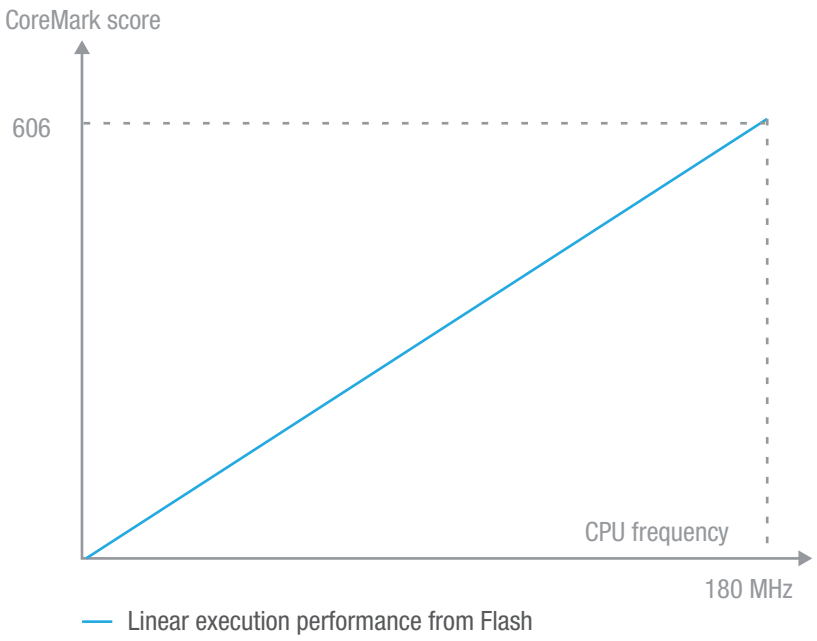
Note:

1. Except LQFP64 and LQFP100 packages
2. TDM :Time Division Multiplex

ART ACCELERATOR PERFORMANCE

Unleashing the full performance of the core beyond the embedded Flash's intrinsic speed is an art. Combined with ST's 90 nm technology, the ART Accelerator™ achieves a linear performance up to 180 MHz, offering 225 DMIPS and 606 CoreMark performance executing from Flash.
The acceleration mechanism is made possible using a prefetch queue, a branch cache and a smart arbitration mechanism.

- MCUs using less advanced accelerators or slower embedded Flash memories impact execution performance as wait states occur.
- MCUs using faster Flash but no branch cache acceleration to achieve performance usually show higher power consumption as a result of more accesses to a power-hungry Flash.

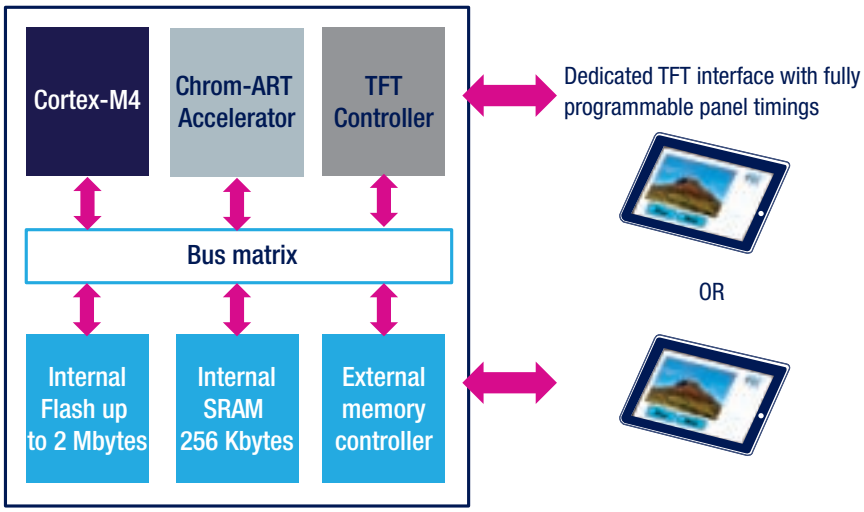


CHROM-ART ACCELERATOR USE CASES

In applications using a TFT LCD display, graphical data generation can consume a lot of CPU bandwidth. To offload the CPU, a dedicated DMA has been developed by ST to perform graphic content copy from the frame buffer (internal or external RAM) to the display interface (FMC or TFT controller). This advanced graphic accelerator, the Chrom-ART Accelerator, achieves twice as much performance versus the CPU.
In addition to raw data copy, additional functionalities are supported such as image format conversion or image blending (image mixing with some transparency).

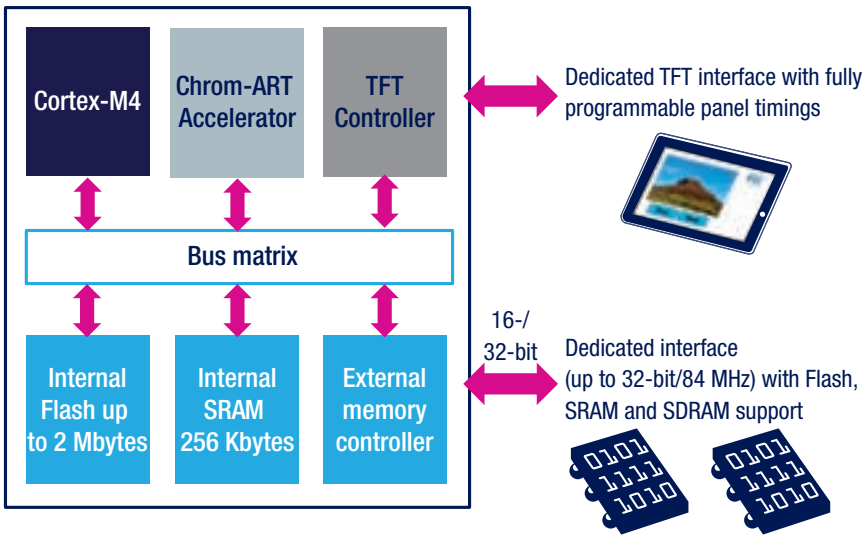
Entry-level HMI

- STM32F4x9 using Chrom-ART Accelerator, internal SRAM for frame buffer and TFT controller or FMC for display
  - Up to QVGA/WQVGA
  - Recommended packages: LQFP100/ LQFP144



Mid/high-end HMI

- STM32F4x9 using Chrom-ART Accelerator, internal or external memory for frame buffer and TFT controller for display
  - Up to VGA/SVGA
  - 16-/32-bit external memory interface
  - Recommended packages: LQFP144, LQFP176/BGA176 or LQFP208/BGA216



Legend:
HMI: Human Machine Interface

Development tools

As for all STM32 products, a complete development tool offering is available, including the following dedicated kits.

- STM32 F4 Discovery kits (order codes: STM32F4DISCOVERY and STM32F429I-DISCO[1]) and expansion boards for STM32F4DISCOVERY (order codes: STM32F4DIS-BB, STM32F4DIS-CAM and STM32F4DIS-LCD)
- STM32 F4 evaluation boards (order codes: STM3240G-EVAL, STM3241G-EVAL, STM32437I-EVAL, STM32429I-EVAL[1] and STM32439I-EVAL[1]
- STM32 F4 starter kits from IAR and Keil (order codes: STM3240G-SK/IAR and STM3240G-SK/KEI)
- STM32 F4 EvoPrimer (order code: STM3240GPRIMER)

Note:

1. Available in Q3/2013

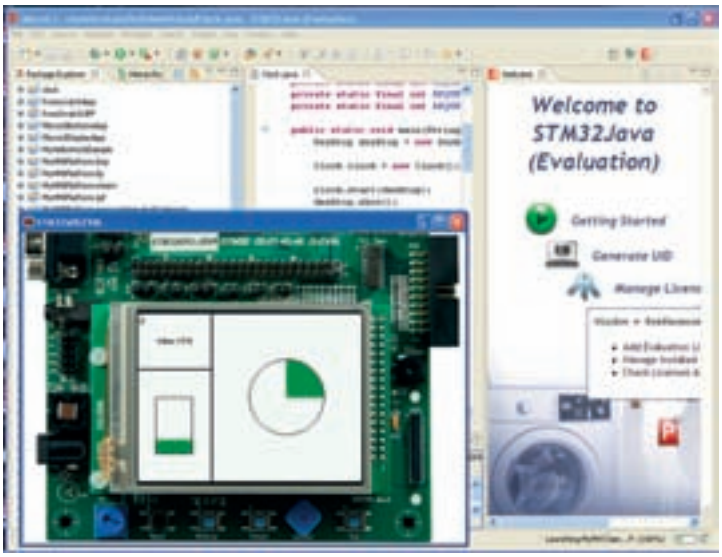
STM32F4DISCOVERY + STM32F4DIS-BB, STM32F4DIS-CAM and STM32F4DIS-LCD

STM3240G-EVAL with STM32F407IGH6 MCU
STM3241G-EVAL with STM32F417IGH6 MCU
STM32437I-EVAL with STM32F437IIH6 MCU

SOFTWARE DEVELOPMENT ENVIRONMENT

In addition to traditional C++ development environments, you can now develop applications in Java or with .NET Micro Framework from Microsoft.

- STM32 F4 series Java evaluation kit (order code: STM3240G-JAVA)
- STM32Java development environment (order code: STM32-JAVA)
- Microsoft .NET Micro Framework platform (order codes: STM3240G-ETH/NMF and STM3240G-USB/NMF)



STM3240G-JAVA

STM3240G-ETH/NMF + STM3240G-USB/NMF

Firmware solutions

From the hardware abstraction layer, through middleware and up to the application field, the STM32 software ecosystem is extensive, providing a consistent set of solutions coming from more than 30 partners, based on open-source, or built in-house.
All STM32 F4 peripherals are functionally covered, including peripheral library, DSP library, crypto library, file systems, USB, Ethernet, display, industrial, audio and motor-control applications.
Contact your local ST sales and marketing office for more information on the solutions described in this document.

HARDWARE ABSTRACTION LAYER

- STM32 F4 standard peripheral and DSP library: Complete set of device drivers for all standard device peripherals with many examples, including a standardized-interface DSP library, with more than 50 math operations (FIR, FFT, matrix, and more) accelerated for the STM32 F4 DSP instruction set.
- STM32 cryptographic library: Implementation of cryptographic algorithms, using STM32F41x hardware acceleration when available, or 100% implemented by software for the others, but with same API.

MIDDLEWARE

- Many RTOS and file systems, from open source to commercial solutions
- STM32 USB Host and Device libraries: Complete firmware packages for USB, slave and host, with many classes covered
- STM32 TCP/IP stacks: Several stacks are available, such as LwIP or NicheLite; partners offer more extensive protocol support, or other communication means such as Wi-Fi
- STemWin graphical library: based on SEGGER emWin graphical library, STemWin is a professional solution, enabling Graphical User Interfaces (GUI) building up with any STM32, and LCD and controller, taking benefit from STM32 Hardware accelerations, whenever possible. It comes with a full set of widgets and services, like remote display and developments tools like on PC simulator and screens designer.
- STM32 Bluetooth stack: iAnywhere full Bluetooth stack with many different profiles, with our partner Alpwise

APPLICATION FIELDS

- STM32 audio solutions: Full range of audio software bricks, optimized for STM32 F4:
  - Adapted transport layers, such as USB synchronization, Bluetooth profiles, and more
  - Music codecs: MP3, WMA, AAC-LC, HE-AACv1, HE-AACv2, OGG Vorbis, SBC, and more
  - Speech codecs: Speex, G726, G711, G729, G722, and more
  - Post-processing algorithms such as loudness control, channel mixer, equalizer, sample rate converter
  - Smartphone accessory libraries, such as iAP (iPod application protocol) interface or Android interfacing

Contact your sales office for information on availability for specific STM32 part numbers.

- STM32 industrial protocols: Full range of supported industrial protocols, including Profinet, EtherCAT, Modbus, DeviceNet, CANopen, and more, via our partner network, taking the most from the STM32 F4 with, in particular, its IEEE 1588 feature for synchronized nodes

Device summary

Part number	Flash size (Kbytes)	Internal RAM size (Kbytes)	Package	Timer functions		12-bit channels		I/Os	Serial interface									Supply voltage (V)	Supply current (Icc)	
				16-/ 32-bit timers	Others	ADC	DAC		SPI	SAI	I²S	I²C	USART + UART[4]	USB OTG FS +FS/ HS	CAN 2.0B	SDIO	Ethernet MAC10 /100		Lowest power mode (µA)	Run mode (per MHz) (µA)
STM32F405/415 line: USB OTG (FS/HS[1]), crypto/hash processor[2] - 168 MHz CPU																				
STM32F4050E	512	192	WLCSP90	12/2	2x WDG, RTC, 24-bit down counter	13	2	72	3		2	2	4+2	2	2	1		1.7[3] to 3.6	2.5	238
STM32F4050G	1024	192	WLCSP90	12/2		13	2	72	3		2	2	4+2	2	2	1		1.7[3] to 3.6	2.5	238
STM32F4150G[2]	1024	192	WLCSP90	12/2		13	2	72	3		2	2	4+2	2	2	1		1.7[3] to 3.6	2.5	238
STM32F405RG	1024	192	LQFP64	12/2		16	2	51	3		2	2	4+2	2	2	1		1.8 to 3.6	2.5	238
STM32F415RG[2]	1024	192	LQFP64	12/2		16	2	51	3		2	2	4+2	2	2	1		1.8 to 3.6	2.5	238
STM32F405VG	1024	192	LQFP100	12/2		16	2	82	3		2	2	4+2	2	2	1		1.8 to 3.6	2.5	238
STM32F415VG[2]	1024	192	LQFP100	12/2		16	2	82	3		2	2	4+2	2	2	1		1.8 to 3.6	2.5	238
STM32F405ZG	1024	192	LQFP144	12/2		24	2	114	3		2	2	4+2	2	2	1		1.7[3] to 3.6	2.5	238
STM32F415ZG[2]	1024	192	LQFP144	12/2		24	2	114	3		2	2	4+2	2	2	1		1.7[3] to 3.6	2.5	238
STM32F407/417 line: 2x USB OTG (FS/HS[1]), camera IF, crypto/hash processor[2] - 168 MHz CPU																				
STM32F407IE	512	192	UFBGA176 LQFP176	12/2	2x WDG, RTC, 24-bit down counter	24	2	140	3		2	2	4+2	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F417IE[2]	512	192	UFBGA176 LQFP176	12/2		24	2	140	3		2	3	4+2	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F407VE	512	192	LQFP100	12/2		16	2	82	3		2	3	4+2	2	2	1	Yes	1.8 to 3.6	2.5	238
STM32F417VE[2]	512	192	LQFP100	12/2		16	2	82	3		2	3	4+2	2	2	1	Yes	1.8 to 3.6	2.5	238
STM32F407ZE	512	192	LQFP144	12/2		24	2	114	3		2	3	4+2	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F417ZE2	512	192	LQFP144	12/2		24	2	114	3		2	3	4+2	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F407IG	1024	192	UFBGA176 LQFP176	12/2		24	2	140	3		2	3	4+2	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F417IG[2]	1024	192	UFBGA176 LQFP176	12/2		24	2	140	3		2	3	4+2	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F407VG	1024	192	LQFP100	12/2		16	2	82	3		2	3	4+2	2	2	1	Yes	1.8 to 3.6	2.5	238
STM32F417VG[2]	1024	192	LQFP100	12/2		16	2	82	3		2	3	4+2	2	2	1	Yes	1.8 to 3.6	2.5	238
STM32F407ZG	1024	192	LQFP144	12/2		24	2	114	3		2	2	4+2	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F417ZG[2]	1024	192	LQFP144	12/2		24	2	114	3		2	2	4+2	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F427/437 line: 2x USB OTG (FS/HS[1]), camera IF, crypto/hash processor[2] - 168 MHz CPU																				
STM32F427IG	1024	256	UFBGA176 LQFP176	12/2	2x WDG, RTC, 24-bit down counter	24	2	140	6		2	3	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F427VG	1024	256	LQFP100	12/2		16	2	82	6		2	3	4+4	2	2	1	Yes	1.8 to 3.6	2.5	238
STM32F427ZG	1024	256	LQFP144	12/2		24	2	114	6		2	3	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F437IG[2]	1024	256	UFBGA176 LQFP176	12/2		24	2	140	6		2	3	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F437VG[2]	1024	256	LQFP100	12/2		16	2	82	6		2	3	4+4	2	2	1	Yes	1.8 to 3.6	2.5	238
STM32F437ZG[2]	1024	256	LQFP144	12/2		24	2	114	6		2	3	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F427II	2048	256	UFBGA176 LQFP176	12/2		24	2	140	6		2	3	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	238

Part number	Flash size (Kbytes)	Internal RAM size (Kbytes)	Package	Timer functions		12-bit channels		I/Os	Serial interface									Supply voltage (V)	Supply current (Icc)	
				16-/ 32-bit timers	Others	ADC	DAC		SPI	SAI	I²S	I²C	USART + UART[4]	USB OTG FS +FS/ HS	CAN 2.0B	SDIO	Ethernet MAC10 /100		Lowest power mode (µA)	Run mode (per MHz) (µA)
STM32F427VI	2048	256	LQFP100	12/2	2x WDG, RTC, 24-bit down counter	16	2	82	6		2	3	4+4	2	2	1	Yes	1.8 to 3.6	2.5	238
STM32F427ZI	2048	256	LQFP144	12/2		24	2	114	6		2	3	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F437II[2]	2048	256	UFBGA176 LQFP176	12/2		24	2	168	6		2	3	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F437VI[2]	2048	256	LQFP100	12/2		16	2	82	6		2	3	4+4	2	2	1	Yes	1.8 to 3.6	2.5	238
STM32F437ZI[2]	2048	256	LQFP144	12/2		24	2	114	6		2	3	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	238
STM32F429/439 line: Same as STM32F427/437 line + TFT LCD controller, SDRAM interface, dual-bank Flash - 180 MHz CPU																				
STM32F429BG	1024	256	LQFP208	12/2	2x WDG, RTC, 24-bit down counter	24	2	176	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F429IG	1024	256	UFBGA176 LQFP176	12/2		24	2	140	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F429NG	1024	256	UFBGA216	12/2		24	2	176	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F429VG	1024	256	LQFP100	12/2		16	2	82	6	1	2	2	4+4	2	2	1	Yes	1.8 to 3.6	2.5	260
STM32F429ZG	1024	256	LQFP144	12/2		24	2	114	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F439BG[2]	1024	256	LQFP208	12/2		24	2	176	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F439IG[2]	1024	256	UFBGA176 LQFP176	12/2		24	2	140	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F439NG[2]	1024	256	UFBGA216	12/2		24	2	176	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F439VG[2]	1024	256	LQFP100	12/2		16	2	82	6	1	2	2	4+4	2	2	1	Yes	1.8 to 3.6	2.5	260
STM32F439ZG[2]	1024	256	LQFP144	12/2		24	2	114	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F429BI	2048	256	LQFP208	12/2		24	2	176	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F429II[2]	2048	256	UFBGA176 LQFP176	12/2		24	2	140	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F429NI	2048	256	UFBGA216	12/2		24	2	176	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F429VI	2048	256	LQFP100	12/2		16	2	82	6	1	2	2	4+4	2	2	1	Yes	1.8 to 3.6	2.5	260
STM32F429ZI	2048	256	LQFP144	12/2		24	2	114	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F439BI[2]	2048	256	LQFP208	12/2		24	2	176	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F439II[2]	2048	256	UFBGA176 LQFP176	12/2		24	2	140	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F439NI[2]	2048	256	UFBGA216	12/2		24	2	176	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260
STM32F439VI[2]	2048	256	LQFP100	12/2		16	2	82	6	1	2	2	4+4	2	2	1	Yes	1.8 to 3.6	2.5	260
STM32F439ZI[2]	2048	256	LQFP144	12/2		24	2	114	6	1	2	2	4+4	2	2	1	Yes	1.7[3] to 3.6	2.5	260

Notes: Operating temperature: -40 to 85 °C for WLCSP packages and -40 to 105 °C for all other packages

1. HS requires an external PHY connected to ULPI interface
2. Crypto/hash processor on STM32F417, STM32F415, STM32F437, STM32F439
3. 1.7 V requires external reset circuitry and the device operates in the 0 to 70 °C temperature range
4. Marked in the table (3+2) means 3 USART and 2 UART. All UARTs have LIN master/slave function. All USARTs have IrDA, ISO 7816, modem control and LIN master/slave functions.

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