



Migration and compatibility guidelines for STM32 microcontroller applications

Introduction

For designers of STM32 microcontroller applications, it is important to be able to easily replace one microcontroller type by another one in the same product series. Migrating an application to a different microcontroller is often needed, when product requirements grow, putting extra demands on memory size, or increasing the number of I/Os. On the other hand, cost reduction objectives may force you to switch to smaller components and shrink the PCB area. This application note is written to help you and analyze the steps you need to migrate from an existing STM32-based design to any one of the other microcontroller types in the fast-growing STM32 series.

To save your time, this application note groups together all the most important information and lists the vital aspects that you need to address.

All the information included here can also be extremely worthwhile in your first STM32 design, not immediately concerned by a migration project. Studying the issues now will help you tackle any future requirement by designing for compatibility from the beginning. To use this application note, general STM32 knowledge is required, you can learn it from the STM32 series reference manual, the STM32 datasheets, and the STM32 Flash program memory programming manuals.

This application note presents an overview of the whole STM32 series and presents a first level view of the different aspects that are important to consider when planning a new design or migrating. The microcontroller blocks and peripherals are grouped and identified either as fully compatible or compatible with enhancements, or presented by types of series.

However the details of the migration guidelines across STM32 series are documented in separate documents. Please refer to one of the following documents:

- AN3427 *Migrating applications from STM32F1 series to STM32F2 series.*
- AN3422 *Migrating applications from STM32F1 series to STM32L1 series.*
- AN4088 *Migrating applications from STM32F1 series to STM32F0 series.*

Table 1. Applicable products

Type	Part numbers
Microcontrollers	STM32F0, STM32F1, STM32F2, STM32F4 and STM32L1 series

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1 How to migrate across STM32 series

1.1 STM32 series general overview

The STM32 platform forms a strong foundation with a broad and growing portfolio. With new products addressing new applications, the complete STM32 product series now comprises several series including **STM32F0**, **STM32F1**, **STM32F2**, **STM32F4** and **STM32L1**, each dedicated to a specific segment:

- **STM32F0**: The F0 series bridges the gap with applications using 8- and 16-bit microcontrollers, enabling advanced high-end features in economical end products. The F0 series offers unparalleled flexibility and scalability for home-entertainment products, appliances, and industrial equipment.
- **STM32F1**: The general-purpose F1 series addresses a wide range of applications, from the lowest, price-sensitive designs to computing-intensive, high memory footprint ones. The F1 series is a complete series whose members are fully pin-to-pin, software and feature compatible.
 - **Low density** devices are STM32F101xx and STM32F103xx microcontrollers where the Flash memory density ranges between 16 and 32 Kbytes.
 - **Medium density** devices are STM32F101xx and STM32F103xx microcontrollers where the Flash memory density ranges between 32 and 128 Kbytes.
 - **High density** devices are STM32F101xx and STM32F103xx microcontrollers where the Flash memory density ranges between 256 and 512 Kbytes.
 - **XL density** devices are STM32F101xx and STM32F103xx microcontrollers where the Flash memory density ranges between 768 Kbytes and 1024 Kbytes.
 - **Connectivity line** devices are STM32F105xx and STM32F107xx microcontrollers where the Flash memory density ranges between 64 and 256 Kbytes.
 - **Medium density value line** devices are STM32F100xx microcontrollers where the Flash memory density ranges between 64 and 128 Kbytes.
 - **High density value line** devices are STM32F100xx microcontrollers where the Flash memory density ranges between 128 and 512 Kbytes.
- **STM32F2**: The F2 series provides the highest performance for computing-intensive applications and advanced connectivity. The F2 series maintains compatibility with the F1 series.
- **STM32F4**: The ARM® Cortex™-M4-based F4 series is an extension of the industry-leading STM32 portfolio towards even higher performance. Like the STM32 F2 series, these MCUs leverage ST's 90 nm NVM technology and ST's ART Accelerator™ to reach the industry's highest benchmark scores for Cortex-M-based microcontrollers with 210 DMIPS/469 Coremark executing from Flash memory at 168 MHz operating frequency.

- **STM32L1:** Designed for ultra-low-power applications that are energy-aware and seek to achieve the absolute lowest power consumption. The L1 series maintains compatibility with the F1 series.
 - **Medium density** devices are STM32L151xx and STM32L152xx microcontrollers where the Flash memory density ranges between 64 and 128 Kbytes.
 - **Medium+ density** devices are STM32L151xx, STM32L152xx and STM32L162xx microcontrollers where the Flash memory density is 256 Kbytes.
 - **High density** devices are STM32L151xx, STM32L152xx and STM32L162xx microcontrollers where the Flash memory density is 384 Kbytes.

In the rest of this document (unless otherwise specified),

- the terms F0, STM32F0 and STM32F0xx are used to refer to the STM32F0 series
- the terms F1, STM32F1 and STM32F10x are used to refer to the STM32F1 series
- the terms F2, STM32F2 and STM32F2xx are used to refer to the STM32F2 series
- the terms F4, STM32F4 and STM32F4xx are used to refer to the STM32F4 series
- the terms L1, STM32L1 and STM32L1xx are used to refer to the STM32L1 series

1.1.1 STM32 product series feature comparison

Table 1. STM32 series overview

Peripheral		STM32 series				
		F1	L1	F2	F0	F4
Core		Cortex-M3 r1p1 MPU in XL-density only	Cortex-M3 r2p0 w/ MPU	Cortex-M3 r2p0 w/ MPU	Cortex-M0	Cortex-M4 r0p1 w/ FPU and MPU
FLASH memory		16 / 32 / 64 / 128 / 256 / 384 / 512 / 768KB - 1 MB	64/128 KB	128 / 256 / 512 / 786 / 1024 KB	64 KB	512 / 1024 KB
SRAM		6 / 10 / 20 / 24 / 32 / 48 / 64 / 96 KB	10/16 KB	64/96/128 KB	8 KB	128 + 64 KB
FSMC		Yes	No	Yes	No	Yes
Max CPU frequency		24 / 36 / 48 / 72 MHz depending on the product line used	32 MHz	120 MHz	48 MHz	168 MHz
Operating voltage		2.0 to 3.6 V	1.65 to 3.6 V	1.8 to 3.6 V	2.0 to 3.6 V	1.8 to 3.6 V
Bootloader		Connectivity Line: USART1/2, CAN2, DFU (OTG FS Device) Other product lines:USART1	Medium density: USART1/2 Medium+ and High density: USART1/2 + DFU (USB Device FS)	USART1/3, CAN2, DFU (OTG FS Device)	USART1/2	USART1/3, CAN2, DFU (OTG FS Device)
Timers	Advanced 4 channel (3 compl. out)	up to 2	No	2	1	2
	General purpose	up to 10	7	up to 10	5 (16-bit) 1 (32-bit)	10
	4 channels	up to 4	4	up to 4	2	4
	2 channels	up to 2	1	up to 2	1(w/ 1Cmpl out)	2
	1 channel	up to 4	2	up to 4	1 + 2(w/ 1compl out)	4
	Basics	up to 2	2	2	1	2
RTC		Counter	Hardware calendar	Hardware calendar	Hardware calendar + subseconds	Hardware calendar + subseconds

Table 1. STM32 series overview (continued)

Peripheral		STM32 series				
		F1	L1	F2	F0	F4
COMs	SPI(I2S)	up to 3(2)	2	3(2)	2(1)	3(2)
	TI mode	No	No	Yes	Yes	Yes
	Max freq.	up to 18 Mbits/s	up to 16 Mbits/s	up to 15 or 30 Mbits/s	up to 18 Mbits/s	up to 37.5 Mbits/s
	Audio freq.	8 kHz up to 96 kHz	No	8 kHz up to 192 kHz	8 kHz to 192 kHz	8 kHz to 192 kHz
	I2C	up to 2	2	3	2	2
	Max freq.	400 kHz	400 kHz	400 kHz	1Mbit/s	400 kHz
	USART	up to 3	3	4	2	4
	UART	up to 2	No	2	-	2
	Max freq.	2.25 or 4.5 Mbit/s	up to 4 Mbit/s	3.75 or 7.5 Mbit/s	6 Mbit/s	10.5 Mbit/s
	USB	USB Device FS OTG FS	USB Device FS	OTG FS OTG HS	No No	OTG FS OTG HS
	CAN	up to 2	No	2	No	2
	SDIO	1	No	1	No	1
	CEC	up to 1	No	No	1	No
Ethernet MAC	Yes w/ HW IEEE 1588 v1	No	Yes w/ HW IEEE1588 v2	No	Yes w/ HW IEEE1588 v2	
GPIOs	26/37/51/80/112	37/51/83	51/82/114/140	27/39/55	up to 140	
12-bit ADC	up to 3	1	3	1	3	
Max sampling freq.	1 MSPS	1 MSPS	2 MSPS	1 MSPS	2.4 MSPS	
Number of channels	10/16/21 channels	16/20/24 channels	16/24 channels	16+3 channels	up to 24 channels	
12-bit DAC	2	2	2	1	2	
Max sampling freq.	1 MS/s	1 MS/s	1 MS/s	1 MS/s	1 MS/s	
Number of channels	2	2	2	1	2	
Comparators	No	2	No	2	No	
LCD (COM x SEG)	No	4x44/ 8x40	No	No	No	
DCMI	No	No	Yes	No	Yes	
Crypto/hash processor	No	No	Yes DES, 3DES, AES 256-bit, SHA-1, MD5, HMAC	No	Yes DES, 3DES, AES 256-bit, SHA-1, MD5, HMAC	

Table 1. STM32 series overview (continued)

Peripheral	STM32 series				
	F1	L1	F2	F0	F4
RNG	No	No	Yes	No	Yes
Package				UFQFPN32	
	VFQFPN36				
	LQFP48	LQFP48		LQFP48	
	VFQFPN48	VFQFN48			
	LQFP64	LQFP64	LQFP64	LQFP64	LQFP64
		BGA64			
	WLCSP64		WLCSP64		
	TFBGA64				
					WLCSP90
	LQFP100	LQFP100	LQFP100		LQFP100
	BGA100	BGA100			
	LFBGA100				
	LQFP144		LQFP144		LQFP144
	BGA144				
			UFBGA176		UFBGA176
				LQFP176	

1.1.2 STM32 product cross-compatibility

The STM32 series embeds a set of peripherals which can be classed in three categories:

- The first category is for the peripherals which are by definition common to all products. Those peripherals are identical, so they have the same structure, registers and control bits. There is no need to perform any firmware change to keep the same functionality at the application level after migration. All the features and behavior remain the same.
- The second category is for the peripherals which are shared by all products but have only minor differences (in general to support new features), so migration from one product to another is very easy and does not need any significant new development effort.
- The third category is for peripherals which have been considerably changed from one product to another (new architecture, new features...). For this category of peripherals, migration will require new development at application level.

Table 2 through to Table 5 gives a general overview of this classification:

Table 2. STM32 peripheral compatibility analysis F1 versus F0 series

Peripheral	Series		Compatibility		
	F1	F0	Comments	Pinout	SW compatibility
SPI	Yes	Yes+	Two FIFO available, 4 bit to 16 bit data size selection	Identical	Partial compatibility
WWDG	Yes	Yes	Same features	NA	Full compatibility
IWDG / IWWDG	Yes	Yes++	Added a Window mode	NA	Partial compatibility
DBGMCU	Yes	Yes	No JTAG, No Trace	Identical for the SWD	Partial compatibility
CRC	Yes	Yes+	Added reverse capability and initial CRC value	NA	Partial compatibility
EXTI	Yes	Yes+	Some peripherals are able to generate event in stop mode	Identical	Full compatibility
CEC	Yes	Yes++	Kernel clock, arbitration lost flag and automatic transmission retry, multi-address config, wake up from stop mode	Identical	Partial compatibility
DMA	Yes	Yes	1 DMA controller with 5 channels	NA	Full compatibility
TIM	Yes	Yes+	Enhancement	Identical	Full compatibility
PWR	Yes	Yes+	No Vref, Vdda can be greater than Vdd, 1.8 mode for core.	Identical for the same feature	Partial compatibility
RCC	Yes	Yes+	New HSI14 dedicated to ADC	PD0 & PD1 => PF0 & PF1 for the osc	Partial compatibility

Table 2. STM32 peripheral compatibility analysis F1 versus F0 series (continued)

Peripheral	Series		Compatibility		
	F1	F0	Comments	Pinout	SW compatibility
USART	Yes	Yes+	Choice for independant clock sources, Time out feature, wake up from stop mode	Identical	Full compatibility
I2C	Yes	Yes++	Bug fix, FM+, wake up from stop mode, Digital filter	Identical	Full compatibility
DAC	Yes	Yes+	DMA underrun interrupt	Identical	Full compatibility
ADC	Yes	Yes++	Same analogic part, but new digital interface	Identical	Partial compatibility
RTC	Yes	Yes++	Subsecond precision, digital calibration circuit, Time-stamp function for event saving, programmable alarm	Identical for the same feature	New driver
FLASH	Yes	Yes+	Option byte modified	NA	Partial compatibility
GPIO	Yes	Yes++	New peripheral	4 new GPIOs	Partial compatibility
CAN	Yes	NA	NA	NA	NA
USB FS device	Yes	NA	NA	NA	NA
Ethernet	Yes	NA	NA	NA	NA
SDIO	Yes	NA	NA	NA	NA
FSMC	Yes	NA	NA	NA	NA
Touch sensing	NA	Yes	NA	NA	NA
COMP	NA	Yes	NA	NA	NA
SYSCFG	NA	Yes	NA	NA	NA

Color key:




-  = New feature or new architecture (Yes++)
-  = Same feature, but specification change or enhancement (Yes+)
-  = Feature not available (NA)

Table 3. STM32 peripheral compatibility analysis F1 versus F2 series

Peripheral	F1 series	F2 series	Compatibility		
			Comments	Pinout	SW compatibility
FSMC	Yes	Yes	Same features	Identical	Full compatibility
WWDG	Yes	Yes	Same features	NA	Full compatibility
IWDG	Yes	Yes	Same features	NA	Full compatibility
DBGMCU	Yes	Yes	Same features	NA	Full compatibility
CRC	Yes	Yes	Same features	NA	Full compatibility
EXTI	Yes	Yes	Same features	Identical	Full compatibility
CAN	Yes	Yes	Same features	Identical	Full compatibility
PWR	Yes	Yes+	Enhancement	NA	Full compatibility for the same feature
RCC	Yes	Yes+	Enhancement	NA	Partial compatibility
SPI	Yes	Yes+	TI mode / Max baudrate	Identical	Full compatibility for the same feature
USART	Yes	Yes+	Limitation fix / Max baudrate / One Sample Bit / Oversampling by 8	Identical	Full compatibility for the same feature
I2C	Yes	Yes+	Limitation fix	Identical	Full compatibility for the same feature
TIM	Yes	Yes+	32-bit Counter in TIM2 and TIM5	Identical	Full compatibility for the same feature
DAC	Yes	Yes+	DMA underrun interrupt	Identical	Full compatibility for the same feature
Ethernet	Yes	Yes+	IEEE1588 v2 / Enhanced DMA descriptor	Identical	Full compatibility for the same feature
SDIO	Yes	Yes+	Limitation fix	Identical	Full compatibility for the same feature
USB OTG FS	Yes	Yes+	- Dynamic trimming capability of SOF framing period in Host mode - Embeds a VBUS sensing control	Identical	Full compatibility for the same feature
RTC	Yes	Yes++	New peripheral	Identical for the same feature	Not compatible
ADC	Yes	Yes++	New peripheral	Identical for the same feature	Partial compatibility
FLASH	Yes	Yes++	New peripheral	NA	Not compatible
DMA	Yes	Yes++	New peripheral	NA	Not compatible

Table 3. STM32 peripheral compatibility analysis F1 versus F2 series (continued)

Peripheral	F1 series	F2 series	Compatibility		
			Comments	Pinout	SW compatibility
GPIO	Yes	Yes++	New peripheral	Identical	Not compatible
CEC	Yes	NA	NA	NA	NA
USB FS Device	Yes	NA	NA	NA	NA
Crypto/hash processor	NA	Yes	NA	NA	NA
RNG	NA	Yes	NA	NA	NA
DCMI	NA	Yes	NA	NA	NA
USB OTG HS	NA	Yes	NA	NA	NA
SYSCFG	NA	Yes	NA	NA	NA

Color key:

- = New feature or new architecture (Yes++)
- = Same feature, but specification change or enhancement (Yes+)
- = Feature not available (NA)

Table 4. STM32 peripheral compatibility analysis F1 versus F4 series

Peripheral	F1 series	F4 series	Compatibility		
			Comments	Pinout	SW compatibility
FSMC	Yes	Yes+	Enhancement	Identical	Full compatibility
WWDG	Yes	Yes	Same features	NA	Full compatibility
IWDG	Yes	Yes	Same features	NA	Full compatibility
DBGMCU	Yes	Yes	Same features	NA	Full compatibility
CRC	Yes	Yes	Same features	NA	Full compatibility
EXTI	Yes	Yes	Same features	Identical	Full compatibility
CAN	Yes	Yes	Same features	Identical	Full compatibility
PWR	Yes	Yes+	Enhancement	NA	Full compatibility
RCC	Yes	Yes+	Enhancement	NA	Partial compatibility
SPI	Yes	Yes+	TI mode / Max baudrate / I2S full duplex	Identical	Full compatibility
USART	Yes	Yes+	Bug fix / Max baudrate / One Sample Bit / Oversampling by 8	Identical	Full compatibility

Table 4. STM32 peripheral compatibility analysis F1 versus F4 series (continued)

Peripheral	F1 series	F4 series	Compatibility		
			Comments	Pinout	SW compatibility
I2C	Yes	Yes+	Bug fix	Identical	Full compatibility
TIM	Yes	Yes+	32-bit Counter in TIM2 and TIM5	Identical	Full compatibility
DAC	Yes	Yes+	DMA underrun interrupt	Identical	Full compatibility
Ethernet	Yes	Yes+	IEEE1588 v2 / Enhanced DMA descriptor	Identical	Full compatibility
SDIO	Yes	Yes+	Bug fix	Identical	Full compatibility
USB OTG FS	Yes	Yes+	- Dynamic trimming capability of SOF framing period in Host mode - Embeds a VBUS sensing control	Identical	Full compatibility
RTC	Yes	Yes++	New peripheral	Identical for the same feature	New driver
ADC	Yes	Yes++	New peripheral	Identical for the same feature	Partial compatibility
FLASH	Yes	Yes++	New peripheral	NA	Partial compatibility
DMA	Yes	Yes++	New peripheral	NA	Partial compatibility
GPIO	Yes	Yes++	New peripheral	Identical	Partial compatibility
CEC	Yes	NA	NA	NA	NA
USB FS Device	Yes	NA	NA	NA	NA
Crypto/hash processor	NA	Yes	NA	NA	NA
RNG	NA	Yes	NA	NA	NA
DCMI	NA	Yes	NA	NA	NA
USB OTG HS	NA	Yes	NA	NA	NA
SYSCFG	NA	Yes	NA	NA	NA

Color key:




-  = New feature or new architecture (Yes++)
-  = Same feature, but specification change or enhancement (Yes+)
-  = Feature not available (NA)




Table 5. STM32 peripheral compatibility analysis F1 versus L1 series

Peripheral	F1 series	L1 series	Compatibility		
			Comments	Pinout	SW compatibility
SPI	Yes	Yes	No I2S in L1 Medium-density series L1 vs. F1: limitation fix	Identical	Full compatibility
WWDG	Yes	Yes	Same features	NA	Full compatibility
IWDG	Yes	Yes	Same features	NA	Full compatibility
DBGMCU	Yes	Yes	Same features	NA	Full compatibility
CRC	Yes	Yes	Same features	NA	Full compatibility
EXTI	Yes	Yes	Same features	Identical	Full compatibility
USB FS Device	Yes	Yes	Same features	Identical	Full compatibility
DMA	Yes	Yes	Same features	NA	Full compatibility
TIM	Yes	Yes	Same features	Identical	Full compatibility
SDIO	Yes	Yes	Same features	Identical	Full compatibility
FSMC	Yes	Yes	Same features but only SRAM/NOR memories are supported	Identical	Full compatibility
PWR	Yes	Yes+	Enhancement	NA	Full compatibility for the same feature
RCC	Yes	Yes+	Enhancement	NA	Partial compatibility
USART	Yes	Yes+	Limitation fix / One Sample Bit method / Oversampling by 8	Identical	Full compatibility
I2C	Yes	Yes+	Limitation fix	Identical	Full compatibility
DAC	Yes	Yes+	DMA underrun interrupt	Identical	Full compatibility
ADC	Yes	Yes++	New peripheral	Identical	Partial compatibility
RTC	Yes	Yes++	New peripheral	Identical for the same feature	Not compatible
FLASH	Yes	Yes++	New peripheral	NA	Not compatible
GPIO	Yes	Yes++	New peripheral	Identical	Not compatible
CAN	Yes	NA	NA	NA	NA
CEC	Yes	NA	NA	NA	NA
Ethernet	Yes	NA	NA	NA	NA

Table 5. STM32 peripheral compatibility analysis F1 versus L1 series (continued)

Peripheral	F1 series	L1 series	Compatibility		
			Comments	Pinout	SW compatibility
LCD glass	NA	Yes	NA	NA	NA
COMP	NA	Yes	NA	NA	NA
SYSCFG	NA	Yes	NA	NA	NA
AES	NA	Yes	NA	NA	NA
OPAMP	NA	Yes	NA	NA	NA

Color key:

-  = New feature or new architecture (Yes++)
-  = Same feature, but specification change or enhancement (Yes+)
-  = Feature not available (NA)

1.2 Software migration

Each STM32 series is supported by a complete range of high-end and low-cost evaluation, software, debugging and programming tools.

This complete line includes third-party solutions that come complete with an integrated development environment and in-circuit debugger/programmer featuring a JTAG and/or SW application interface. Developers who are new to this series and the Cortex™ core can also benefit from the range of starter kits that are specially designed to help developers evaluate device features and start their own applications.

Thanks to ST firmware libraries and a comprehensive set of application notes, STM32 microcontrollers offer a complete software interface to reduce the time to market and keep the user code independent from hardware details. The state-of-the-art and highly efficient library of software drivers combined with extensive support for all major tool providers offers a fast route to best-fit and an optimized development process.

2 Revision history

Table 6. Document revision history

Date	Revision	Changes
20-Jul-2011	1	Initial release
01-Mar-2012	2	Added medium+ and high-density STM32L1 devices
30-May-2012	3	Added STM32F0 and STM32F4 devices

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