6 Reset and clock control (RCC) for STM32F401xB/C and STM32F401xD/E

6.1 Reset

There are three types of reset, defined as system Reset, power Reset and backup domain Reset.

6.1.1 System reset

A system reset sets all registers to their reset values except the reset flags in the clock controller CSR register and the registers in the Backup domain.

A system reset is generated when one of the following events occurs:

1. A low level on the NRST pin (external reset)
2. Window watchdog end of count condition (WWDG reset)
3. Independent watchdog end of count condition (IWDG reset)
4. A software reset (SW reset) (see *Software reset*)
5. Low-power management reset (see *Low-power management reset*)

Software reset

The reset source can be identified by checking the reset flags in the *RCC clock control & status register (RCC_CSR)*.

The SYSRESETREQ bit in Cortex®-M4 with FPU Application Interrupt and Reset Control Register must be set to force a software reset on the device. Refer to the Cortex®-M4 with FPU technical reference manual for more details.

Low-power management reset

There are two ways of generating a low-power management reset:

1. Reset generated when entering the Standby mode:

   This type of reset is enabled by resetting the nRST_STDBY bit in the user option bytes. In this case, whenever a Standby mode entry sequence is successfully executed, the device is reset instead of entering the Standby mode.

2. Reset when entering the Stop mode:

   This type of reset is enabled by resetting the nRST_STOP bit in the user option bytes. In this case, whenever a Stop mode entry sequence is successfully executed, the device is reset instead of entering the Stop mode.

For further information on the user option bytes, refer to the STM32F401xB/C and STM32F401xD/E Flash programming manual available from your ST sales office.

6.1.2 Power reset

A power reset is generated when one of the following events occurs:

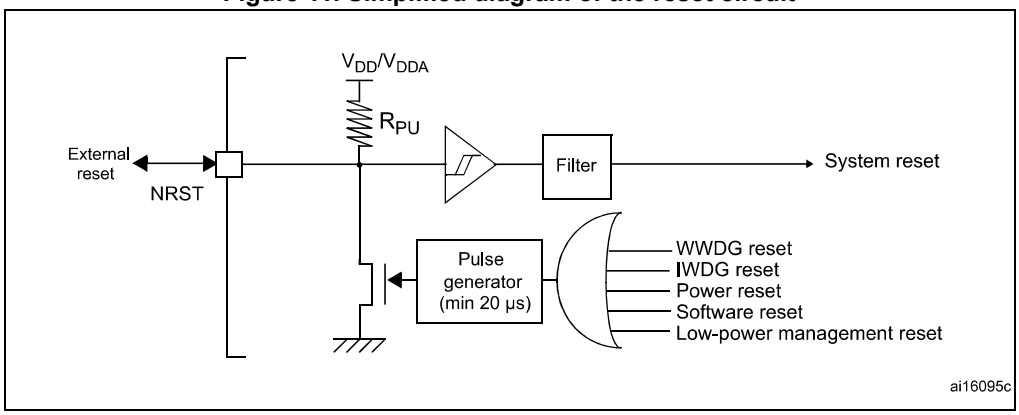
1. Power-on/power-down reset (POR/PDR reset) or brownout (BOR) reset
2. When exiting the Standby mode

A power reset sets all registers to their reset values except the Backup domain.

These sources act on the NRST pin and it is always kept low during the delay phase. The RESET service routine vector is fixed at address 0x0000_0004 in the memory map.

The system reset signal provided to the device is output on the NRST pin. The pulse generator guarantees a minimum reset pulse duration of 20 µs for each internal reset source. In case of an external reset, the reset pulse is generated while the NRST pin is asserted low.

Figure 11. Simplified diagram of the reset circuit



6.1.3 Backup domain reset

The backup domain reset sets all RTC registers and the RCC_BDCR register to their reset values.

A backup domain reset is generated when one of the following events occurs:

1. Software reset, triggered by setting the BDRST bit in the *RCC Backup domain control register (RCC_BDCR)*.
2. V_{DD} or V_{BAT} power on, if both supplies have previously been powered off.

6.2 Clocks

Three different clock sources can be used to drive the system clock (SYSCLK):

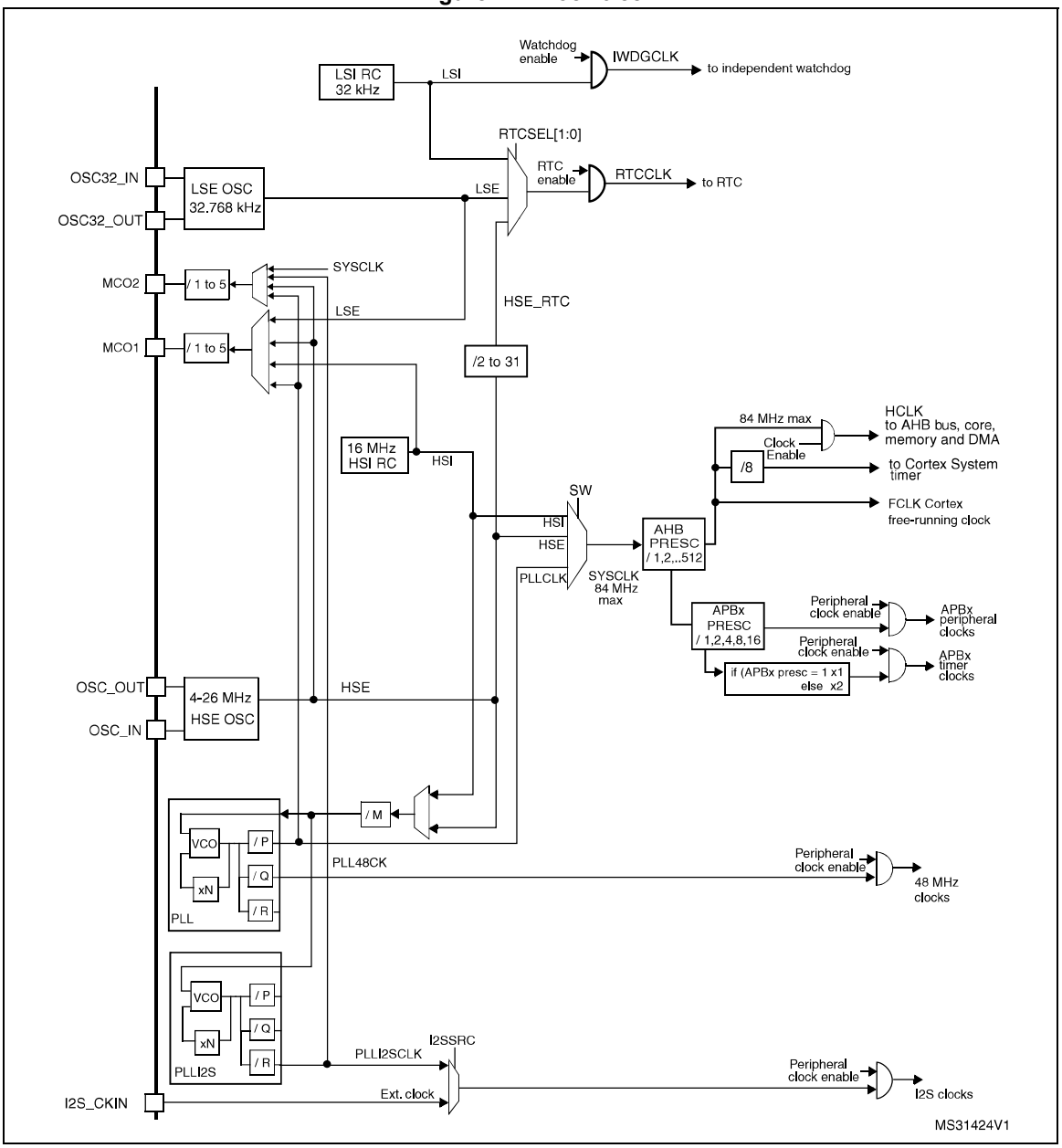
- HSI oscillator clock
- HSE oscillator clock
- Main PLL (PLL) clock

The devices have the two following secondary clock sources:

- 32 kHz low-speed internal RC (LSI RC) which drives the independent watchdog and, optionally, the RTC used for Auto-wakeup from the Stop/Standby mode.
- 32.768 kHz low-speed external crystal (LSE crystal) which optionally drives the RTC clock (RTCCLK)

Each clock source can be switched on or off independently when it is not used, to optimize power consumption.

Figure 12. Clock tree



1. For full details about the internal and external clock source characteristics, refer to the Electrical characteristics section in the device datasheet.

The clock controller provides a high degree of flexibility to the application in the choice of the external crystal or the oscillator to run the core and peripherals at the highest frequency and, guarantee the appropriate frequency for peripherals that need a specific clock like USB OTG FS, I2S and SDIO.

Several prescalers are used to configure the AHB frequency, the high-speed APB (APB2) and the low-speed APB (APB1) domains. The maximum frequency of the AHB domain is 84 MHz. The maximum allowed frequency of the high-speed APB2 domain is 84 MHz. The maximum allowed frequency of the low-speed APB1 domain is 42 MHz

All peripheral clocks are derived from the system clock (SYSCLK) except for:

- The USB OTG FS clock (48 MHz) and the SDIO clock (≤48 MHz) which are coming from a specific output of PLL (PLL48CLK)
- The I2S clock

  To achieve high-quality audio performance, the I2S clock can be derived either from a specific PLL (PLLI2S) or from an external clock mapped on the I2S_CKIN pin. For more information about I2S clock frequency and precision, refer to *Section 20.4.4: Clock generator*.

The RCC feeds the external clock of the Cortex System Timer (SysTick) with the AHB clock (HCLK) divided by 8. The SysTick can work either with this clock or with the Cortex clock (HCLK), configurable in the SysTick control and status register.

The timer clock frequencies for STM32F401xB/C and STM32F401xD/E are automatically set by hardware. There are two cases:

1. If the APB prescaler is 1, the timer clock frequencies are set to the same frequency as that of the APB domain to which the timers are connected.
2. Otherwise, they are set to twice (×2) the frequency of the APB domain to which the timers are connected.

The timer clock frequencies are automatically set by hardware. There are two cases depending on the value of TIMPRE bit in RCC_DCKCFGR register:

- If TIMPRE bit is reset:

  If the APB prescaler is configured to a division factor of 1, the timer clock frequencies (TIMxCLK) are set to HCLK. Otherwise, the timer clock frequencies are twice the frequency of the APB domain to which the timers are connected: TIMxCLK = 2xPCLKx.
- If TIMPRE bit is set:

  If the APB prescaler is configured to a division factor of 1 or 2, the timer clock frequencies (TIMxCLK) are set to HCLK. Otherwise, the timer clock frequencies is four times the frequency of the APB domain to which the timers are connected: TIMxCLK = 4xPCLKx.

FCLK acts as Cortex®-M4 with FPU free-running clock. For more details, refer to the Cortex®-M4 with FPU technical reference manual.

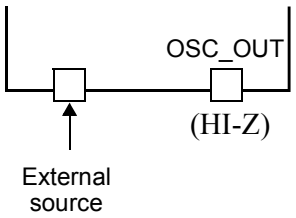
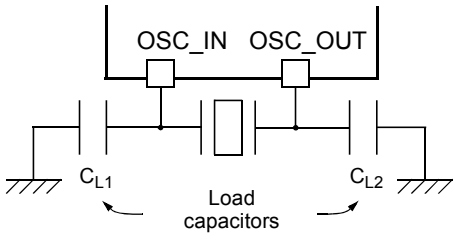
6.2.1 HSE clock

The high speed external clock signal (HSE) can be generated from two possible clock sources:

- HSE external crystal/ceramic resonator
- HSE external user clock

The resonator and the load capacitors have to be placed as close as possible to the oscillator pins in order to minimize output distortion and startup stabilization time. The loading capacitance values must be adjusted according to the selected oscillator.

Figure 13. HSE/ LSE clock sources

	Hardware configuration
External clock	
Crystal/ceramic resonators	

External source (HSE bypass)

In this mode, an external clock source must be provided. You select this mode by setting the HSEBYP and HSEON bits in the *RCC clock control register (RCC_CR)*. The external clock signal (square, sinus or triangle) with ~50% duty cycle has to drive the OSC_IN pin while the OSC_OUT pin should be left HI-Z. See *Figure 13*.

External crystal/ceramic resonator (HSE crystal)

The HSE has the advantage of producing a very accurate rate on the main clock.

The associated hardware configuration is shown in *Figure 13*. Refer to the electrical characteristics section of the *datasheet* for more details.

The HSERDY flag in the *RCC clock control register (RCC_CR)* indicates if the high-speed external oscillator is stable or not. At startup, the clock is not released until this bit is set by hardware. An interrupt can be generated if enabled in the *RCC clock interrupt register (RCC_CIR)*.

The HSE Crystal can be switched on and off using the HSEON bit in the *RCC clock control register (RCC_CR)*.

6.2.2 HSI clock

The HSI clock signal is generated from an internal 16 MHz RC oscillator and can be used directly as a system clock, or used as PLL input.

The HSI RC oscillator has the advantage of providing a clock source at low cost (no external components). It also has a faster startup time than the HSE crystal oscillator however, even with calibration the frequency is less accurate than an external crystal oscillator or ceramic resonator.

Calibration

RC oscillator frequencies can vary from one chip to another due to manufacturing process variations, this is why each device is factory calibrated by ST for 1% accuracy at T_A= 25 °C.

After reset, the factory calibration value is loaded in the HSICAL[7:0] bits in the *RCC clock control register (RCC_CR)*.

If the application is subject to voltage or temperature variations this may affect the RC oscillator speed. You can trim the HSI frequency in the application using the HSITRIM[4:0] bits in the *RCC clock control register (RCC_CR)*.

The HSIRDY flag in the *RCC clock control register (RCC_CR)* indicates if the HSI RC is stable or not. At startup, the HSI RC output clock is not released until this bit is set by hardware.

The HSI RC can be switched on and off using the HSION bit in the *RCC clock control register (RCC_CR)*.

The HSI signal can also be used as a backup source (Auxiliary clock) if the HSE crystal oscillator fails. Refer to *Section 6.2.7: Clock security system (CSS) on page 99*.

6.2.3 PLL configuration

The STM32F401xB/C and STM32F401xD/E devices feature two PLLs:

- A main PLL (PLL) clocked by the HSE or HSI oscillator and featuring two different output clocks:
  - The first output is used to generate the high speed system clock (up to 84 MHz)
  - The second output is used to generate the clock for the USB OTG FS (48 MHz), the random analog generator (≤48 MHz) and the SDIO (≤48 MHz).
- A dedicated PLL (PLLI2S) used to generate an accurate clock to achieve high-quality audio performance on the I2S interface.

Since the main-PLL configuration parameters cannot be changed once PLL is enabled, it is recommended to configure PLL before enabling it (selection of the HSI or HSE oscillator as PLL clock source, and configuration of division factors M, P, Q and multiplication factor N).

The PLLI2S uses the same input clock as the main PLL (PLLM[5:0] and PLLSRC bits are common to both PLLs). However, the PLLI2S has dedicated enable/disable and division factors configuration bits. Refer to *Section 6.3.1: RCC clock control register (RCC_CR)*, *Section 6.3.2: RCC PLL configuration register (RCC_PLLCFGR)* and *Section 6.3.20: RCC PLLI2S configuration register (RCC_PLLI2SCFGR)*. Once the PLLI2S is enabled, the configuration parameters cannot be changed.

The two PLLs are disabled by hardware when entering Stop and Standby modes, or when an HSE failure occurs when HSE or PLL (clocked by HSE) are used as system clock. *RCC*

PLL configuration register (RCC_PLLCFGR) and *RCC clock configuration register (RCC_CFGR)* can be used to configure PLL and PLLI2S, respectively.

6.2.4 LSE clock

The LSE clock is generated using a 32.768kHz low speed external crystal or ceramic resonator. It has the advantage providing a low-power but highly accurate clock source to the real-time clock peripheral (RTC) for clock/calendar or other timing functions.

The LSE oscillator is switched on and off using the LSEON bit in *RCC Backup domain control register (RCC_BDCR)*.

The LSERDY flag in the *RCC Backup domain control register (RCC_BDCR)* indicates if the LSE crystal is stable or not. At startup, the LSE crystal output clock signal is not released until this bit is set by hardware. An interrupt can be generated if enabled in the *RCC clock interrupt register (RCC_CIR)*.

External source (LSE bypass)

In this mode, an external clock source must be provided. It must have a frequency up to 1 MHz. You select this mode by setting the LSEBYP and LSEON bits in the *RCC Backup domain control register (RCC_BDCR)*. The external clock signal (square, sinus or triangle) with ~50% duty cycle has to drive the OSC32_IN pin while the OSC32_OUT pin should be left HI-Z. See *Figure 13*.

6.2.5 LSI clock

The LSI RC acts as an low-power clock source that can be kept running in Stop and Standby mode for the independent watchdog (IWDG) and Auto-wakeup unit (AWU). The clock frequency is around 32 kHz. For more details, refer to the electrical characteristics section of the datasheets.

The LSI RC can be switched on and off using the LSION bit in the *RCC clock control & status register (RCC_CSR)*.

The LSIRDY flag in the *RCC clock control & status register (RCC_CSR)* indicates if the low-speed internal oscillator is stable or not. At startup, the clock is not released until this bit is set by hardware. An interrupt can be generated if enabled in the *RCC clock interrupt register (RCC_CIR)*.

6.2.6 System clock (SYSCLK) selection

After a system reset, the HSI oscillator is selected as the system clock. When a clock source is used directly or through PLL as the system clock, it is not possible to stop it.

A switch from one clock source to another occurs only if the target clock source is ready (clock stable after startup delay or PLL locked). If a clock source that is not yet ready is selected, the switch occurs when the clock source is ready. Status bits in the *RCC clock control register (RCC_CR)* indicate which clock(s) is (are) ready and which clock is currently used as the system clock.

6.2.7 Clock security system (CSS)

The clock security system can be activated by software. In this case, the clock detector is enabled after the HSE oscillator startup delay, and disabled when this oscillator is stopped.

If a failure is detected on the HSE clock, this oscillator is automatically disabled, a clock failure event is sent to the break inputs of advanced-control timer TIM1, and an interrupt is generated to inform the software about the failure (clock security system interrupt CSSI), allowing the MCU to perform rescue operations. The CSSI is linked to the Cortex®-M4 with FPU NMI (non-maskable interrupt) exception vector.

Note: When the CSS is enabled, if the HSE clock happens to fail, the CSS generates an interrupt, which causes the automatic generation of an NMI. The NMI is executed indefinitely unless the CSS interrupt pending bit is cleared. As a consequence, the application has to clear the CSS interrupt in the NMI ISR by setting the CSSC bit in the Clock interrupt register (RCC_CIR).

If the HSE oscillator is used directly or indirectly as the system clock (indirectly meaning that it is directly used as PLL input clock, and that PLL clock is the system clock) and a failure is detected, then the system clock switches to the HSI oscillator and the HSE oscillator is disabled.

If the HSE oscillator clock was the clock source of PLL used as the system clock when the failure occurred, PLL is also disabled. In this case, if the PLLI2S was enabled, it is also disabled when the HSE fails.

6.2.8 RTC/AWU clock

Once the RTCCLK clock source has been selected, the only possible way of modifying the selection is to reset the power domain.

The RTCCLK clock source can be either the HSE 1 MHz (HSE divided by a programmable prescaler), the LSE or the LSI clock. This is selected by programming the RTCSEL[1:0] bits in the *RCC Backup domain control register (RCC_BDCR)* and the RTCPRE[4:0] bits in *RCC clock configuration register (RCC_CFGR)*. This selection cannot be modified without resetting the Backup domain.

If the LSE is selected as the RTC clock, the RTC will work normally if the backup or the system supply disappears. If the LSI is selected as the AWU clock, the AWU state is not guaranteed if the system supply disappears. If the HSE oscillator divided by a value between 2 and 31 is used as the RTC clock, the RTC state is not guaranteed if the backup or the system supply disappears.

The LSE clock is in the Backup domain, whereas the HSE and LSI clocks are not. As a consequence:

- If LSE is selected as the RTC clock:
  - The RTC continues to work even if the V_{DD} supply is switched off, provided the V_{BAT} supply is maintained.
- If LSI is selected as the Auto-wakeup unit (AWU) clock:
  - The AWU state is not guaranteed if the V_{DD} supply is powered off. Refer to *Section 6.2.5: LSI clock on page 98* for more details on LSI calibration.
- If the HSE clock is used as the RTC clock:
  - The RTC state is not guaranteed if the V_{DD} supply is powered off or if the internal voltage regulator is powered off (removing power from the 1.2 V domain).

Note: To read the RTC calendar register when the APB1 clock frequency is less than seven times the RTC clock frequency ($f_{APB1} < 7xf_{RTCLCK}$), the software must read the calendar time and date registers twice. The data are correct if the second read access to RTC_TR gives the same result than the first one. Otherwise a third read access must be performed.

6.2.9 Watchdog clock

If the independent watchdog (IWDG) is started by either hardware option or software access, the LSI oscillator is forced ON and cannot be disabled. After the LSI oscillator temporization, the clock is provided to the IWDG.

6.2.10 Clock-out capability

Two microcontroller clock output (MCO) pins are available:

- MCO1

  You can output four different clock sources onto the MCO1 pin (PA8) using the configurable prescaler (from 1 to 5):

  – HSI clock
  – LSE clock
  – HSE clock
  – PLL clock

  The desired clock source is selected using the MCO1PRE[2:0] and MCO1[1:0] bits in the *RCC clock configuration register (RCC_CFGR)*.

- MCO2

  You can output four different clock sources onto the MCO2 pin (PC9) using the configurable prescaler (from 1 to 5):

  – HSE clock
  – PLL clock
  – System clock (SYSCLK)
  – PLLI2S clock

  The desired clock source is selected using the MCO2PRE[2:0] and MCO2 bits in the *RCC clock configuration register (RCC_CFGR)*.

For the different MCO pins, the corresponding GPIO port has to be programmed in alternate function mode.

The selected clock to output onto MCO must not exceed 100 MHz (the maximum I/O speed).

6.2.11 Internal/external clock measurement using TIM5/TIM11

It is possible to indirectly measure the frequencies of all on-board clock source generators by means of the input capture of TIM5 channel4 and TIM11 channel1 as shown in *Figure 14* and *Figure 15*.

Internal/external clock measurement using TIM5 channel4

TIM5 has an input multiplexer which allows choosing whether the input capture is triggered by the I/O or by an internal clock. This selection is performed through the TI4_RMP [1:0] bits in the TIM5_OR register.

The primary purpose of having the LSE connected to the channel4 input capture is to be able to precisely measure the HSI (this requires to have the HSI used as the system clock source). The number of HSI clock counts between consecutive edges of the LSE signal provides a measurement of the internal clock period. Taking advantage of the high precision of LSE crystals (typically a few tens of ppm) we can determine the internal clock frequency with the same resolution, and trim the source to compensate for manufacturing-process and/or temperature- and voltage-related frequency deviations.

The HSI oscillator has dedicated, user-accessible calibration bits for this purpose.

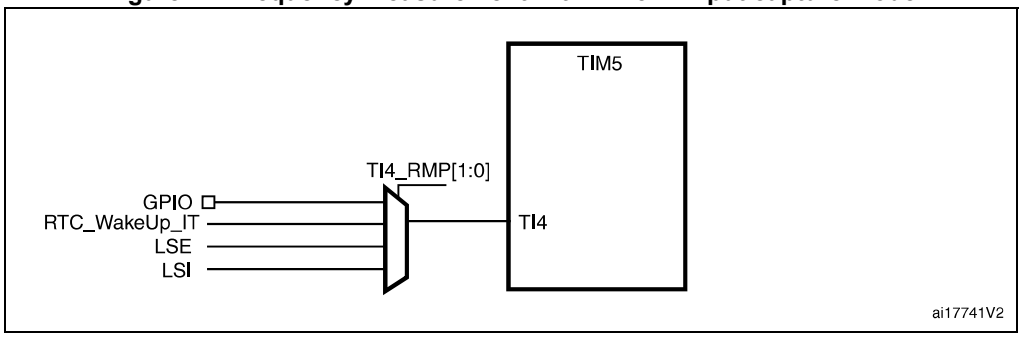
The basic concept consists in providing a relative measurement (e.g. HSI/LSE ratio): the precision is therefore tightly linked to the ratio between the two clock sources. The greater the ratio, the better the measurement.

It is also possible to measure the LSI frequency: this is useful for applications that do not have a crystal. The ultralow-power LSI oscillator has a large manufacturing process deviation: by measuring it versus the HSI clock source, it is possible to determine its frequency with the precision of the HSI. The measured value can be used to have more accurate RTC time base timeouts (when LSI is used as the RTC clock source) and/or an IWDG timeout with an acceptable accuracy.

Use the following procedure to measure the LSI frequency:

1. Enable the TIM5 timer and configure channel4 in Input capture mode.
2. Set the TI4_RMP bits in the TIM5_OR register to 0x01 to connect the LSI clock internally to TIM5 channel4 input capture for calibration purposes.
3. Measure the LSI clock frequency using the TIM5 capture/compare 4 event or interrupt.
4. Use the measured LSI frequency to update the prescaler of the RTC depending on the desired time base and/or to compute the IWDG timeout.

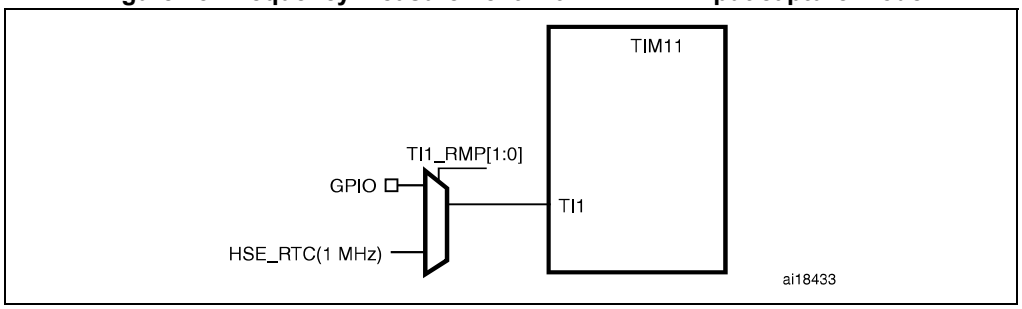
Figure 14. Frequency measurement with TIM5 in Input capture mode



Internal/external clock measurement using TIM11 channel1

TIM11 has an input multiplexer which allows choosing whether the input capture is triggered by the I/O or by an internal clock. This selection is performed through TI1_RMP [1:0] bits in the TIM11_OR register. The HSE_RTC clock (HSE divided by a programmable prescaler) is connected to channel 1 input capture to have a rough indication of the external crystal frequency. This requires that the HSI is the system clock source. This can be useful for instance to ensure compliance with the IEC 60730/IEC 61335 standards which require to be able to determine harmonic or subharmonic frequencies (–50/+100% deviations).

Figure 15. Frequency measurement with TIM11 in Input capture mode



6.3 RCC registers

Refer to *Section 1.1: List of abbreviations for registers* for a list of abbreviations used in register descriptions.

6.3.1 RCC clock control register (RCC_CR)

Address offset: 0x00

Reset value: 0x0000 XX81 where X is undefined.

Access: no wait state, word, half-word and byte access

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved				PLLI2S RDY	PLLI2S ON	PLLRDY	PLLON	Reserved				CSS ON	HSE BYP	HSE RDY	HSE ON
				r	rw	r	rw					rw	rw	r	rw

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
HSICAL[7:0]								HSITRIM[4:0]					Res.	HSI RDY	HSION
r	r	r	r	r	r	r	r	rw	rw	rw	rw	rw		r	rw

Bits 31:28 Reserved, must be kept at reset value.

Bit 27 **PLLI2SRDY**: PLLI2S clock ready flag
Set by hardware to indicate that the PLLI2S is locked.
0: PLLI2S unlocked
1: PLLI2S locked

Bit 26 **PLLI2SON**: PLLI2S enable
Set and cleared by software to enable PLLI2S.
Cleared by hardware when entering Stop or Standby mode.
0: PLLI2S OFF
1: PLLI2S ON

Bit 25 **PLLRDY**: Main PLL (PLL) clock ready flag
Set by hardware to indicate that PLL is locked.
0: PLL unlocked
1: PLL locked

Bit 24 **PLLON**: Main PLL (PLL) enable
Set and cleared by software to enable PLL.
Cleared by hardware when entering Stop or Standby mode. This bit cannot be reset if PLL clock is used as the system clock.
0: PLL OFF
1: PLL ON

Bits 23:20 Reserved, must be kept at reset value.

Bit 19 **CSSON**: Clock security system enable
Set and cleared by software to enable the clock security system. When CSSON is set, the clock detector is enabled by hardware when the HSE oscillator is ready, and disabled by hardware if an oscillator failure is detected.
0: Clock security system OFF (Clock detector OFF)
1: Clock security system ON (Clock detector ON if HSE oscillator is stable, OFF if not)

Bit 18 **HSEBYP**: HSE clock bypass

Set and cleared by software to bypass the oscillator with an external clock. The external clock must be enabled with the HSEON bit, to be used by the device.
The HSEBYP bit can be written only if the HSE oscillator is disabled.
0: HSE oscillator not bypassed
1: HSE oscillator bypassed with an external clock

Bit 17 **HSERDY**: HSE clock ready flag

Set by hardware to indicate that the HSE oscillator is stable. After the HSEON bit is cleared, HSERDY goes low after 6 HSE oscillator clock cycles.
0: HSE oscillator not ready
1: HSE oscillator ready

Bit 16 **HSEON**: HSE clock enable

Set and cleared by software.
Cleared by hardware to stop the HSE oscillator when entering Stop or Standby mode. This bit cannot be reset if the HSE oscillator is used directly or indirectly as the system clock.
0: HSE oscillator OFF
1: HSE oscillator ON

Bits 15:8 **HSICAL[7:0]**: Internal high-speed clock calibration

These bits are initialized automatically at startup.

Bits 7:3 **HSITRIM[4:0]**: Internal high-speed clock trimming

These bits provide an additional user-programmable trimming value that is added to the HSICAL[7:0] bits. It can be programmed to adjust to variations in voltage and temperature that influence the frequency of the internal HSI RC.

Bit 2 Reserved, must be kept at reset value.

Bit 1 **HSIRDY**: Internal high-speed clock ready flag

Set by hardware to indicate that the HSI oscillator is stable. After the HSION bit is cleared, HSIRDY goes low after 6 HSI clock cycles.
0: HSI oscillator not ready
1: HSI oscillator ready

Bit 0 **HSION**: Internal high-speed clock enable

Set and cleared by software.
Set by hardware to force the HSI oscillator ON when leaving the Stop or Standby mode or in case of a failure of the HSE oscillator used directly or indirectly as the system clock. This bit cannot be cleared if the HSI is used directly or indirectly as the system clock.
0: HSI oscillator OFF
1: HSI oscillator ON

6.3.2 RCC PLL configuration register (RCC_PLLCFGR)

Address offset: 0x04

Reset value: 0x2400 3010

Access: no wait state, word, half-word and byte access.

This register is used to configure the PLL clock outputs according to the formulas:

- $f_{(VCO\ clock)} = f_{(PLL\ clock\ input)} \times (PLLN / PLLM)$
- $f_{(PLL\ general\ clock\ output)} = f_{(VCO\ clock)} / PLLP$
- $f_{(USB\ OTG\ FS,\ SDIO,\ RNG\ clock\ output)} = f_{(VCO\ clock)} / PLLQ$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved				PLLQ3	PLLQ2	PLLQ1	PLLQ0	Reserved	PLLSRC	Reserved				PLLP1	PLLP0
				rw	rw	rw	rw		rw					rw	rw

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved	PLLN									PLLM5	PLLM4	PLLM3	PLLM2	PLLM1	PLLM0
	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw

Bit 31:28 Reserved, must be kept at reset value.

Bits 27:24 **PLLQ:** Main PLL (PLL) division factor for USB OTG FS, SDIO and random number generator clocks

Set and cleared by software to control the frequency of USB OTG FS clock, the random number generator clock and the SDIO clock. These bits should be written only if PLL is disabled.

Caution: The USB OTG FS requires a 48 MHz clock to work correctly. The SDIO and the random number generator need a frequency lower than or equal to 48 MHz to work correctly.

USB OTG FS clock frequency = VCO frequency / PLLQ with $2 \leq PLLQ \leq 15$

0000: PLLQ = 0, wrong configuration
0001: PLLQ = 1, wrong configuration
0010: PLLQ = 2
0011: PLLQ = 3
0100: PLLQ = 4
...
1111: PLLQ = 15

Bit 23 Reserved, must be kept at reset value.

Bit 22 **PLLSRC:** Main PLL(PLL) and audio PLL (PLLI2S) entry clock source

Set and cleared by software to select PLL and PLLI2S clock source. This bit can be written only when PLL and PLLI2S are disabled.

0: HSI clock selected as PLL and PLLI2S clock entry
1: HSE oscillator clock selected as PLL and PLLI2S clock entry

Bits 21:18 Reserved, must be kept at reset value.

Bits 17:16 **PLLP:** Main PLL (PLL) division factor for main system clock

Set and cleared by software to control the frequency of the general PLL output clock. These bits can be written only if PLL is disabled.

Caution: The software has to set these bits correctly not to exceed 84 MHz on this domain.

PLL output clock frequency = VCO frequency / PLLP with PLLP = 2, 4, 6, or 8

00: PLLP = 2

01: PLLP = 4

10: PLLP = 6

11: PLLP = 8

Bits 14:6 **PLLN:** Main PLL (PLL) multiplication factor for VCO

Set and cleared by software to control the multiplication factor of the VCO. These bits can be written only when PLL is disabled. Only half-word and word accesses are allowed to write these bits.

Caution: The software has to set these bits correctly to ensure that the VCO output frequency is between 192 and 432 MHz. (check also *Section 6.3.20: RCC PLLI2S configuration register (RCC_PLLI2SCFGR)*)

VCO output frequency = VCO input frequency × PLLN with 192 ≤PLLN ≤432

000000000: PLLN = 0, wrong configuration

000000001: PLLN = 1, wrong configuration

...

...

110110000: PLLN = 432

110110001: PLLN = 433, wrong configuration

...

111111111: PLLN = 511, wrong configuration

Bits 5:0 **PLLM:** Division factor for the main PLL (PLL) and audio PLL (PLLI2S) input clock

Set and cleared by software to divide the PLL and PLLI2S input clock before the VCO. These bits can be written only when the PLL and PLLI2S are disabled.

Caution: The software has to set these bits correctly to ensure that the VCO input frequency ranges from 1 to 2 MHz. It is recommended to select a frequency of 2 MHz to limit PLL jitter.

VCO input frequency = PLL input clock frequency / PLLM with 2 ≤PLLM ≤63

000000: PLLM = 0, wrong configuration

000001: PLLM = 1, wrong configuration

000010: PLLM = 2

000011: PLLM = 3

000100: PLLM = 4

...

111110: PLLM = 62

111111: PLLM = 63

6.3.3 RCC clock configuration register (RCC_CFGR)

Address offset: 0x08

Reset value: 0x0000 0000

Access: 0 ≤ wait state ≤ 2, word, half-word and byte access

1 or 2 wait states inserted only if the access occurs during a clock source switch.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
MCO2		MCO2 PRE[2:0]			MCO1 PRE[2:0]			I2SSCR	MCO1		RTCPRE[4:0]				
rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
PPRE2[2:0]			PPRE1[2:0]			Reserved		HPRE[3:0]				SWS1	SWS0	SW1	SW0
rw	rw	rw	rw	rw	rw			rw	rw	rw	rw	r	r	rw	rw

Bits 31:30 **MCO2[1:0]:** Microcontroller clock output 2

Set and cleared by software. Clock source selection may generate glitches on MCO2. It is highly recommended to configure these bits only after reset before enabling the external oscillators and the PLLs.

00: System clock (SYSCLK) selected

01: PLLI2S clock selected

10: HSE oscillator clock selected

11: PLL clock selected

Bits 29:27 **MCO2PRE:** MCO2 prescaler

Set and cleared by software to configure the prescaler of the MCO2. Modification of this prescaler may generate glitches on MCO2. It is highly recommended to change this prescaler only after reset before enabling the external oscillators and the PLLs.

0xx: no division

100: division by 2

101: division by 3

110: division by 4

111: division by 5

Bits 26:24 **MCO1PRE:** MCO1 prescaler

Set and cleared by software to configure the prescaler of the MCO1. Modification of this prescaler may generate glitches on MCO1. It is highly recommended to change this prescaler only after reset before enabling the external oscillators and the PLL.

0xx: no division

100: division by 2

101: division by 3

110: division by 4

111: division by 5

Bit 23 **I2SSRC**: I2S clock selection

Set and cleared by software. This bit allows to select the I2S clock source between the PLLI2S clock and the external clock. It is highly recommended to change this bit only after reset and before enabling the I2S module.

0: PLLI2S clock used as I2S clock source

1: External clock mapped on the I2S_CKIN pin used as I2S clock source

Bits 22:21 **MCO1:** Microcontroller clock output 1

Set and cleared by software. Clock source selection may generate glitches on MCO1. It is highly recommended to configure these bits only after reset before enabling the external oscillators and PLL.

00: HSI clock selected
01: LSE oscillator selected
10: HSE oscillator clock selected
11: PLL clock selected

Bits 20:16 **RTCPRE:** HSE division factor for RTC clock

Set and cleared by software to divide the HSE clock input clock to generate a 1 MHz clock for RTC.

Caution: The software has to set these bits correctly to ensure that the clock supplied to the RTC is 1 MHz. These bits must be configured if needed before selecting the RTC clock source.

00000: no clock
00001: no clock
00010: HSE/2
00011: HSE/3
00100: HSE/4
...
11110: HSE/30
11111: HSE/31

Bits 15:13 **PPRE2:** APB high-speed prescaler (APB2)

Set and cleared by software to control APB high-speed clock division factor.

Caution: The software has to set these bits correctly not to exceed 84 MHz on this domain. The clocks are divided with the new prescaler factor from 1 to 16 AHB cycles after PPRE2 write.

0xx: AHB clock not divided
100: AHB clock divided by 2
101: AHB clock divided by 4
110: AHB clock divided by 8
111: AHB clock divided by 16

Bits 12:10 **PPRE1:** APB Low speed prescaler (APB1)

Set and cleared by software to control APB low-speed clock division factor.

Caution: The software has to set these bits correctly not to exceed 42 MHz on this domain. The clocks are divided with the new prescaler factor from 1 to 16 AHB cycles after PPRE1 write.

0xx: AHB clock not divided
100: AHB clock divided by 2
101: AHB clock divided by 4
110: AHB clock divided by 8
111: AHB clock divided by 16

Bits 9:8 Reserved, must be kept at reset value.

Bits 7:4 **HPRE:** AHB prescaler

Set and cleared by software to control AHB clock division factor.

Caution: The clocks are divided with the new prescaler factor from 1 to 16 AHB cycles after HPRE write.

0xxx: system clock not divided
1000: system clock divided by 2
1001: system clock divided by 4
1010: system clock divided by 8
1011: system clock divided by 16
1100: system clock divided by 64
1101: system clock divided by 128
1110: system clock divided by 256
1111: system clock divided by 512

Bits 3:2 **SWS:** System clock switch status

Set and cleared by hardware to indicate which clock source is used as the system clock.
00: HSI oscillator used as the system clock
01: HSE oscillator used as the system clock
10: PLL used as the system clock
11: not applicable

Bits 1:0 **SW:** System clock switch

Set and cleared by software to select the system clock source.

Set by hardware to force the HSI selection when leaving the Stop or Standby mode or in case of failure of the HSE oscillator used directly or indirectly as the system clock.
00: HSI oscillator selected as system clock
01: HSE oscillator selected as system clock
10: PLL selected as system clock
11: not allowed

6.3.4 RCC clock interrupt register (RCC_CIR)

Address offset: 0x0C

Reset value: 0x0000 0000

Access: no wait state, word, half-word and byte access

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved								CSSC	Reserved	PLLI2S RDYC	PLL RDYC	HSE RDYC	HSI RDYC	LSE RDYC	LSI RDYC
								w		w	w	w	w	w	w
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved		PLLI2S RDYIE	PLL RDYIE	HSE RDYIE	HSI RDYIE	LSE RDYIE	LSI RDYIE	CSSF	Reserved	PLLI2S RDYF	PLL RDYF	HSE RDYF	HSI RDYF	LSE RDYF	LSI RDYF
		rw	rw	rw	rw	rw	rw	r		r	r	r	r	r	r

Bits 31:24 Reserved, must be kept at reset value.

Bit 23 **CSSC:** Clock security system interrupt clear
This bit is set by software to clear the CSSF flag.
0: No effect
1: Clear CSSF flag

Bit 22 Reserved, must be kept at reset value.

Bit 21 **PLLI2SRDYC:** PLLI2S ready interrupt clear
This bit is set by software to clear the PLLI2SRDYF flag.
0: No effect
1: PLLI2SRDYF cleared

Bit 20 **PLLRDYC:** Main PLL(PLL) ready interrupt clear
This bit is set by software to clear the PLLRDYF flag.
0: No effect
1: PLLRDYF cleared

Bit 19 **HSERDYC:** HSE ready interrupt clear
This bit is set by software to clear the HSERDYF flag.
0: No effect
1: HSERDYF cleared

Bit 18 **HSIRDYC:** HSI ready interrupt clear
This bit is set software to clear the HSIRDYF flag.
0: No effect
1: HSIRDYF cleared

Bit 17 **LSERDYC:** LSE ready interrupt clear
This bit is set by software to clear the LSERDYF flag.
0: No effect
1: LSERDYF cleared

Bit 16 **LSIRDYC:** LSI ready interrupt clear
This bit is set by software to clear the LSIRDYF flag.
0: No effect
1: LSIRDYF cleared

Bits 15:14 Reserved, must be kept at reset value.

Bit 13 **PLLI2SRDYIE:** PLLI2S ready interrupt enable
Set and cleared by software to enable/disable interrupt caused by PLLI2S lock.
0: PLLI2S lock interrupt disabled
1: PLLI2S lock interrupt enabled

Bit 12 **PLLRDYIE:** Main PLL (PLL) ready interrupt enable
Set and cleared by software to enable/disable interrupt caused by PLL lock.
0: PLL lock interrupt disabled
1: PLL lock interrupt enabled

Bit 11 **HSERDYIE:** HSE ready interrupt enable
Set and cleared by software to enable/disable interrupt caused by the HSE oscillator stabilization.
0: HSE ready interrupt disabled
1: HSE ready interrupt enabled

Bit 10 **HSIRDYIE:** HSI ready interrupt enable
Set and cleared by software to enable/disable interrupt caused by the HSI oscillator stabilization.
0: HSI ready interrupt disabled
1: HSI ready interrupt enabled

Bit 9 **LSERDYIE:** LSE ready interrupt enable
Set and cleared by software to enable/disable interrupt caused by the LSE oscillator stabilization.
0: LSE ready interrupt disabled
1: LSE ready interrupt enabled

Bit 8 **LSIRDYIE:** LSI ready interrupt enable
Set and cleared by software to enable/disable interrupt caused by LSI oscillator stabilization.
0: LSI ready interrupt disabled
1: LSI ready interrupt enabled

Bit 7 **CSSF:** Clock security system interrupt flag
Set by hardware when a failure is detected in the HSE oscillator.
Cleared by software setting the CSSC bit.
0: No clock security interrupt caused by HSE clock failure
1: Clock security interrupt caused by HSE clock failure

Bit 6 Reserved, must be kept at reset value.

Bit 5 **PLLI2SRDYF:** PLLI2S ready interrupt flag
Set by hardware when the PLLI2S locks and PLLI2SRDYDIE is set.
Cleared by software setting the PLLRI2SDYC bit.
0: No clock ready interrupt caused by PLLI2S lock
1: Clock ready interrupt caused by PLLI2S lock

Bit 4 **PLLRDYF:** Main PLL (PLL) ready interrupt flag
Set by hardware when PLL locks and PLLRDYDIE is set.
Cleared by software setting the PLLRDYC bit.
0: No clock ready interrupt caused by PLL lock
1: Clock ready interrupt caused by PLL lock

Bit 3 **HSERDYF:** HSE ready interrupt flag
Set by hardware when External High Speed clock becomes stable and HSERDYDIE is set.
Cleared by software setting the HSERDYC bit.
0: No clock ready interrupt caused by the HSE oscillator
1: Clock ready interrupt caused by the HSE oscillator

Bit 2 **HSIRDYF:** HSI ready interrupt flag
Set by hardware when the Internal High Speed clock becomes stable and HSIRDYDIE is set.
Cleared by software setting the HSIRDYC bit.
0: No clock ready interrupt caused by the HSI oscillator
1: Clock ready interrupt caused by the HSI oscillator

Bit 1 **LSERDYF:** LSE ready interrupt flag
Set by hardware when the External Low Speed clock becomes stable and LSERDYDIE is set.
Cleared by software setting the LSERDYC bit.
0: No clock ready interrupt caused by the LSE oscillator
1: Clock ready interrupt caused by the LSE oscillator

Bit 0 **LSIRDYF:** LSI ready interrupt flag
Set by hardware when the internal low speed clock becomes stable and LSIRDYDIE is set.
Cleared by software setting the LSIRDYC bit.
0: No clock ready interrupt caused by the LSI oscillator
1: Clock ready interrupt caused by the LSI oscillator

6.3.5 RCC AHB1 peripheral reset register (RCC_AHB1RSTR)

Address offset: 0x10

Reset value: 0x0000 0000

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved									DMA2RST	DMA1RST	Reserved				
									rw	rw					

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved			CRCRST	Reserved				GPIOHRST	Reserved		GPIOERST	GPIODRST	GPIOCRST	GPIOBRST	GPIOARST
			rw					rw			rw	rw	rw	rw	rw

Bits 31:23 Reserved, must be kept at reset value.

Bit 22 **DMA2RST:** DMA2 reset
Set and cleared by software.
0: does not reset DMA2
1: resets DMA2

Bit 21 **DMA1RST:** DMA1 reset
Set and cleared by software.
0: does not reset DMA1
1: resets DMA1

Bits 20:13 Reserved, must be kept at reset value.

Bit 12 **CRCRST:** CRC reset
Set and cleared by software.
0: does not reset CRC
1: resets CRC

Bits 11:8 Reserved, must be kept at reset value.

Bit 7 **GPIOHRST:** IO port H reset
Set and cleared by software.
0: does not reset IO port H
1: resets IO port H

Bits 6:5 Reserved, must be kept at reset value.

Bit 4 **GPIOERST:** IO port E reset
Set and cleared by software.
0: does not reset IO port E
1: resets IO port E

Bit 3 **GPIODRST:** IO port D reset
Set and cleared by software.
0: does not reset IO port D
1: resets IO port D

Bit 2 **GPIOCRST:** IO port C reset
Set and cleared by software.
0: does not reset IO port C
1: resets IO port C

Bit 1 **GPIOBRST:** IO port B reset
Set and cleared by software.
0: does not reset IO port B
1:resets IO port B

Bit 0 **GPIOARST:** IO port A reset
Set and cleared by software.
0: does not reset IO port A
1: resets IO port A

6.3.6 RCC AHB2 peripheral reset register (RCC_AHB2RSTR)

Address offset: 0x14

Reset value: 0x0000 0000

Access: no wait state, word, half-word and byte access

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved								OTGFS RST	Reserved						
								rw							

Bits 31:8 Reserved, must be kept at reset value.

Bit 6:0 Reserved, must be kept at reset value.

6.3.7 RCC APB1 peripheral reset register for (RCC_APB1RSTR)

Address offset: 0x20

Reset value: 0x0000 0000

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved			PWR RST	Reserved				I2C3 RST	I2C2 RST	I2C1 RST	Reserved			USART2 RST	Reser-ved
			rw					rw	rw	rw				rw	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SPI3 RST	SPI2 RST	Reserved		WWDG RST	Reserved							TIM5 RST	TIM4 RST	TIM3 RST	TIM2 RST
rw	rw			rw								rw	rw	rw	rw

Bits 31:29 Reserved, must be kept at reset value.

Bit 28 **PWRRST:** Power interface reset
Set and cleared by software.
0: does not reset the power interface
1: resets the power interface

Bits 27:24 Reserved, must be kept at reset value.

Bit 23 **I2C3RST:** I2C3 reset
Set and cleared by software.
0: does not reset I2C3
1: resets I2C3

Bit 22 **I2C2RST:** I2C2 reset
Set and cleared by software.
0: does not reset I2C2
1: resets I2C2

Bit 21 **I2C1RST:** I2C1 reset
Set and cleared by software.
0: does not reset I2C1
1: resets I2C1

Bits 20:18 Reserved, must be kept at reset value.

Bit 17 **USART2RST:** USART2 reset
Set and cleared by software.
0: does not reset USART2
1: resets USART2

Bit 16 Reserved, must be kept at reset value.

Bit 15 **SPI3RST:** SPI3 reset
Set and cleared by software.
0: does not reset SPI3
1: resets SPI3

Bit 14 **SPI2RST:** SPI2 reset
Set and cleared by software.
0: does not reset SPI2
1: resets SPI2

Bits 13:12 Reserved, must be kept at reset value.

Bit 11 **WWDGRST:** Window watchdog reset
Set and cleared by software.
0: does not reset the window watchdog
1: resets the window watchdog

Bits 10:4 Reserved, must be kept at reset value.

Bit 3 **TIM5RST:** TIM5 reset
Set and cleared by software.
0: does not reset TIM5
1: resets TIM5

Bit 2 **TIM4RST:** TIM4 reset
Set and cleared by software.
0: does not reset TIM4
1: resets TIM4

Bit 1 **TIM3RST:** TIM3 reset
Set and cleared by software.
0: does not reset TIM3
1: resets TIM3

Bit 0 **TIM2RST:** TIM2 reset
Set and cleared by software.
0: does not reset TIM2
1: resets TIM2

6.3.8 RCC APB2 peripheral reset register (RCC_APB2RSTR)

Address offset: 0x24

Reset value: 0x0000 0000

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved													TIM11 RST	TIM10 RST	TIM9 RST
													rw	rw	rw

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reser-ved	SYSCFG RST	SPI4 RST	SPI1 RST	SDIO RST	Reserved		ADC1 RST	Reserved		USART6 RST	USART1 RST	Reserved			TIM1 RST
	rw	rw	rw	rw			rw			rw	rw				rw

Bits 31:19 Reserved, must be kept at reset value.

Bit 18 **TIM11RST:** TIM11 reset
Set and cleared by software.
0: does not reset TIM11
1: resets TIM11

Bit 17 **TIM10RST:** TIM10 reset
Set and cleared by software.
0: does not reset TIM10
1: resets TIM10

Bit 16 **TIM9RST:** TIM9 reset
Set and cleared by software.
0: does not reset TIM9
1: resets TIM9

Bit 15 Reserved, must be kept at reset value.

Bit 14 **SYSCFGRST:** System configuration controller reset
Set and cleared by software.
0: does not reset the System configuration controller
1: resets the System configuration controller

Bit 13 **SPI4RST:** SPI4 reset
Set and reset by software.
0: does not reset SPI4
1: resets SPI4

Bit 12 **SPI1RST:** SPI1 reset
Set and cleared by software.
0: does not reset SPI1
1: resets SPI1

Bit 11 **SDIORST:** SDIO reset
Set and cleared by software.
0: does not reset the SDIO module
1: resets the SDIO module

Bits 10:9 Reserved, must be kept at reset value.

Bit 8 **ADC1RST:** ADC interface reset
Set and cleared by software.
0: does not reset the ADC interface
1: resets the ADC interface

Bits 7:6 Reserved, must be kept at reset value.

Bit 5 **USART6RST:** USART6 reset
Set and cleared by software.
0: does not reset USART6
1: resets USART6

Bit 4 **USART1RST:** USART1 reset
Set and cleared by software.
0: does not reset USART1
1: resets USART1

Bits 3:1 Reserved, must be kept at reset value.

Bit 0 **TIM1RST:** TIM1 reset
Set and cleared by software.
0: does not reset TIM1
1: resets TIM1

6.3.9 RCC AHB1 peripheral clock enable register (RCC_AHB1ENR)

Address offset: 0x30

Reset value: 0x0000 0000

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved									DMA2EN	DMA1EN	Reserved				
									rw	rw					

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved			CRCEN	Reserved				GPIOHEN	Reserved		GPIOEEN	GPIODEN	GPIOCEN	GPIOBEN	GPIOAEN
			rw					rw			rw	rw	rw	rw	rw

Bits 31:23 Reserved, must be kept at reset value.

Bit 22 **DMA2EN:** DMA2 clock enable
Set and cleared by software.
0: DMA2 clock disabled
1: DMA2 clock enabled

Bit 21 **DMA1EN:** DMA1 clock enable
Set and cleared by software.
0: DMA1 clock disabled
1: DMA1 clock enabled

Bits 20:13 Reserved, must be kept at reset value.

Bit 12 **CRCEN:** CRC clock enable
Set and cleared by software.
0: CRC clock disabled
1: CRC clock enabled

Bits 11:8 Reserved, must be kept at reset value.

Bit 7 **GPIOHEN**: IO port H clock enable
Set and reset by software.
0: IO port H clock disabled
1: IO port H clock enabled

Bits 6:5 Reserved, must be kept at reset value.

Bit 4 **GPIOEEN:** IO port E clock enable
Set and cleared by software.
0: IO port E clock disabled
1: IO port E clock enabled

Bit 3 **GPIODEN:** IO port D clock enable
Set and cleared by software.
0: IO port D clock disabled
1: IO port D clock enabled

Bit 2 **GPIOCEN:** IO port C clock enable
Set and cleared by software.
0: IO port C clock disabled
1: IO port C clock enabled

Bit 1 **GPIOBEN:** IO port B clock enable
Set and cleared by software.
0: IO port B clock disabled
1: IO port B clock enabled

Bit 0 **GPIOAEN:** IO port A clock enable
Set and cleared by software.
0: IO port A clock disabled
1: IO port A clock enabled

6.3.10 RCC AHB2 peripheral clock enable register (RCC_AHB2ENR)

Address offset: 0x34

Reset value: 0x0000 0000

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved								OTGFSEN	Reserved						
								rw							

Bits 31:8 Reserved, must be kept at reset value.

Bit 7 **OTGFSEN:** USB OTG FS clock enable
Set and cleared by software.
0: USB OTG FS clock disabled
1: USB OTG FS clock enabled

Bits 6:0 Reserved, must be kept at reset value.

6.3.11 RCC APB1 peripheral clock enable register (RCC_APB1ENR)

Address offset: 0x40

Reset value: 0x0000 0000

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved			PWREN	Reserved				I2C3EN	I2C2EN	I2C1EN	Reserved			USART2EN	Reserved
			rw					rw	rw	rw				rw	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SPI3EN	SPI2EN	Reserved		WWDGEN	Reserved							TIM5EN	TIM4EN	TIM3EN	TIM2EN
rw	rw			rw								rw	rw	rw	rw

Bits 31:29 Reserved, must be kept at reset value.

Bit 28 **PWREN:** Power interface clock enable
Set and cleared by software.
0: Power interface clock disabled
1: Power interface clock enable

Bits 27:24 Reserved, must be kept at reset value.

Bit 23 **I2C3EN:** I2C3 clock enable
Set and cleared by software.
0: I2C3 clock disabled
1: I2C3 clock enabled

Bit 22 **I2C2EN:** I2C2 clock enable
Set and cleared by software.
0: I2C2 clock disabled
1: I2C2 clock enabled

Bit 21 **I2C1EN:** I2C1 clock enable
Set and cleared by software.
0: I2C1 clock disabled
1: I2C1 clock enabled

Bits 20:18 Reserved, must be kept at reset value.

Bit 17 **USART2EN:** USART2 clock enable
Set and cleared by software.
0: USART2 clock disabled
1: USART2 clock enabled

Bit 16 Reserved, must be kept at reset value.

Bit 15 **SPI3EN:** SPI3 clock enable
Set and cleared by software.
0: SPI3 clock disabled
1: SPI3 clock enabled

Bit 14 **SPI2EN:** SPI2 clock enable
Set and cleared by software.
0: SPI2 clock disabled
1: SPI2 clock enabled

Bits 13:12 Reserved, must be kept at reset value.

Bit 11 **WWDGEN:** Window watchdog clock enable
Set and cleared by software.
0: Window watchdog clock disabled
1: Window watchdog clock enabled

Bits 10:4 Reserved, must be kept at reset value.

Bit 3 **TIM5EN:** TIM5 clock enable
Set and cleared by software.
0: TIM5 clock disabled
1: TIM5 clock enabled

Bit 2 **TIM4EN:** TIM4 clock enable
Set and cleared by software.
0: TIM4 clock disabled
1: TIM4 clock enabled

Bit 1 **TIM3EN:** TIM3 clock enable
Set and cleared by software.
0: TIM3 clock disabled
1: TIM3 clock enabled

Bit 0 **TIM2EN:** TIM2 clock enable
Set and cleared by software.
0: TIM2 clock disabled
1: TIM2 clock enabled

6.3.12 RCC APB2 peripheral clock enable register (RCC_APB2ENR)

Address offset: 0x44

Reset value: 0x0000 0000

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved													TIM11 EN	TIM10 EN	TIM9 EN
													rw	rw	rw

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reser-ved	SYSCFG EN	SPI4EN	SPI1 EN	SDIO EN	Reserved		ADC1 EN	Reserved		USART6 EN	USART1 EN	Reserved			TIM1 EN
	rw	rw	rw	rw			rw			rw	rw				rw

Bits 31:19 Reserved, must be kept at reset value.

Bit 18 **TIM11EN:** TIM11 clock enable
Set and cleared by software.
0: TIM11 clock disabled
1: TIM11 clock enabled

Bit 17 **TIM10EN:** TIM10 clock enable
Set and cleared by software.
0: TIM10 clock disabled
1: TIM10 clock enabled

Bit 16 **TIM9EN:** TIM9 clock enable
Set and cleared by software.
0: TIM9 clock disabled
1: TIM9 clock enabled

Bit 15 Reserved, must be kept at reset value.

Bit 14 **SYSCFGEN:** System configuration controller clock enable
Set and cleared by software.
0: System configuration controller clock disabled
1: System configuration controller clock enabled

Bit 13 **SPI4EN:** SPI4 clock enable
Set and reset by software.
0: SPI4 clock disabled
1: SPI4 clock enable

Bit 12 **SPI1EN:** SPI1 clock enable
Set and cleared by software.
0: SPI1 clock disabled
1: SPI1 clock enabled

Bit 11 **SDIOEN:** SDIO clock enable
Set and cleared by software.
0: SDIO module clock disabled
1: SDIO module clock enabled

Bit 8 **ADC1EN:** ADC1 clock enable
Set and cleared by software.
0: ADC1 clock disabled
1: ADC1 clock disabled

Bits 7:6 Reserved, must be kept at reset value.

Bit 5 **USART6EN:** USART6 clock enable
Set and cleared by software.
0: USART6 clock disabled
1: USART6 clock enabled

Bit 4 **USART1EN:** USART1 clock enable
Set and cleared by software.
0: USART1 clock disabled
1: USART1 clock enabled

Bits 3:1 Reserved, must be kept at reset value.

Bit 0 **TIM1EN:** TIM1 clock enable
Set and cleared by software.
0: TIM1 clock disabled
1: TIM1 clock enabled

6.3.13 RCC AHB1 peripheral clock enable in low power mode register (RCC_AHB1LPENR)

Address offset: 0x50

Reset value: 0x0061 900F

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved									DMA2 LPEN	DMA1 LPEN	Reserved				SRAM1 LPEN
									rw	rw					rw

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
FLITF LPEN	Reserved		CRC LPEN	Reserved				GPIOH LPEN	Reserved		GPIOE LPEN	GPIOD LPEN	GPIOC LPEN	GPIOB LPEN	GPIOA LPEN
rw			rw					rw			rw	rw	rw	rw	rw

Bits 31:23 Reserved, must be kept at reset value.

Bit 22 **DMA2LPEN:** DMA2 clock enable during Sleep mode
Set and cleared by software.
0: DMA2 clock disabled during Sleep mode
1: DMA2 clock enabled during Sleep mode

Bit 21 **DMA1LPEN:** DMA1 clock enable during Sleep mode
Set and cleared by software.
0: DMA1 clock disabled during Sleep mode
1: DMA1 clock enabled during Sleep mode

Bits 20:17 Reserved, must be kept at reset value.

Bit 16 **SRAM1LPEN:** SRAM1interface clock enable during Sleep mode
Set and cleared by software.
0: SRAM1 interface clock disabled during Sleep mode
1: SRAM1 interface clock enabled during Sleep mode

Bit 15 **FLITFLPEN:** Flash interface clock enable during Sleep mode
Set and cleared by software.
0: Flash interface clock disabled during Sleep mode
1: Flash interface clock enabled during Sleep mode

Bits 14:13 Reserved, must be kept at reset value.

Bit 12 **CRCLPEN:** CRC clock enable during Sleep mode
Set and cleared by software.
0: CRC clock disabled during Sleep mode
1: CRC clock enabled during Sleep mode

Bits 11:8 Reserved, must be kept at reset value.

Bit 7 **GPIOHLPEN:** IO port H clock enable during sleep mode
Set and reset by software.
0: IO port H clock disabled during sleep mode
1: IO port H clock enabled during sleep mode

Bits 6:5 Reserved, must be kept at reset value.

Bit 4 **GPIOELPEN:** IO port E clock enable during Sleep mode
Set and cleared by software.
0: IO port E clock disabled during Sleep mode
1: IO port E clock enabled during Sleep mode

Bit 3 **GPIODLPEN:** IO port D clock enable during Sleep mode
Set and cleared by software.
0: IO port D clock disabled during Sleep mode
1: IO port D clock enabled during Sleep mode

Bit 2 **GPIOCLPEN:** IO port C clock enable during Sleep mode
Set and cleared by software.
0: IO port C clock disabled during Sleep mode
1: IO port C clock enabled during Sleep mode

Bit 1 **GPIOBLPEN:** IO port B clock enable during Sleep mode
Set and cleared by software.
0: IO port B clock disabled during Sleep mode
1: IO port B clock enabled during Sleep mode

Bit 0 **GPIOALPEN:** IO port A clock enable during sleep mode
Set and cleared by software.
0: IO port A clock disabled during Sleep mode
1: IO port A clock enabled during Sleep mode

6.3.14 RCC AHB2 peripheral clock enable in low power mode register (RCC_AHB2LPENR)

Address offset: 0x54

Reset value: 0x0000 0080

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved								OTGFS LPEN	Reserved						
								rw							

Bits 31:8 Reserved, must be kept at reset value.

Bit 7 **OTGFSLPEN:** USB OTG FS clock enable during Sleep mode
Set and cleared by software.
0: USB OTG FS clock disabled during Sleep mode
1: USB OTG FS clock enabled during Sleep mode

Bits 6:0 Reserved, must be kept at reset value.

6.3.15 RCC APB1 peripheral clock enable in low power mode register (RCC_APB1LPENR)

Address offset: 0x60

Reset value: 0x10E2 C80F

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved			PWR LPEN	Reserved				I2C3 LPEN	I2C2 LPEN	I2C1 LPEN	Reserved			USART2 LPEN	Reser-ved
			rw					rw	rw	rw				rw	

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SPI3 LPEN	SPI2 LPEN	Reserved		WWDG LPEN	Reserved							TIM5 LPEN	TIM4 LPEN	TIM3 LPEN	TIM2 LPEN
rw	rw			rw								rw	rw	rw	rw

Bits 31:29 Reserved, must be kept at reset value.

Bit 28 **PWRLPEN:** Power interface clock enable during Sleep mode
Set and cleared by software.
0: Power interface clock disabled during Sleep mode
1: Power interface clock enabled during Sleep mode

Bits 27:24 Reserved, must be kept at reset value.

Bit 23 **I2C3LPEN:** I2C3 clock enable during Sleep mode
Set and cleared by software.
0: I2C3 clock disabled during Sleep mode
1: I2C3 clock enabled during Sleep mode

Bit 22 **I2C2LPEN:** I2C2 clock enable during Sleep mode
Set and cleared by software.
0: I2C2 clock disabled during Sleep mode
1: I2C2 clock enabled during Sleep mode

Bit 21 **I2C1LPEN:** I2C1 clock enable during Sleep mode
Set and cleared by software.
0: I2C1 clock disabled during Sleep mode
1: I2C1 clock enabled during Sleep mode

Bits 20:18 Reserved, must be kept at reset value.

Bit 17 **USART2LPEN:** USART2 clock enable during Sleep mode
Set and cleared by software.
0: USART2 clock disabled during Sleep mode
1: USART2 clock enabled during Sleep mode

Bit 16 Reserved, must be kept at reset value.

Bit 15 **SPI3LPEN:** SPI3 clock enable during Sleep mode
Set and cleared by software.
0: SPI3 clock disabled during Sleep mode
1: SPI3 clock enabled during Sleep mode

Bit 14 **SPI2LPEN:** SPI2 clock enable during Sleep mode
Set and cleared by software.
0: SPI2 clock disabled during Sleep mode
1: SPI2 clock enabled during Sleep mode

Bits 13:12 Reserved, must be kept at reset value.

Bit 11 **WWDGLPEN:** Window watchdog clock enable during Sleep mode
Set and cleared by software.
0: Window watchdog clock disabled during sleep mode
1: Window watchdog clock enabled during sleep mode

Bits 10:4 Reserved, must be kept at reset value.

Bit 3 **TIM5LPEN:** TIM5 clock enable during Sleep mode
Set and cleared by software.
0: TIM5 clock disabled during Sleep mode
1: TIM5 clock enabled during Sleep mode

Bit 2 **TIM4LPEN:** TIM4 clock enable during Sleep mode
Set and cleared by software.
0: TIM4 clock disabled during Sleep mode
1: TIM4 clock enabled during Sleep mode

Bit 1 **TIM3LPEN:** TIM3 clock enable during Sleep mode
Set and cleared by software.
0: TIM3 clock disabled during Sleep mode
1: TIM3 clock enabled during Sleep mode

Bit 0 **TIM2LPEN:** TIM2 clock enable during Sleep mode
Set and cleared by software.
0: TIM2 clock disabled during Sleep mode
1: TIM2 clock enabled during Sleep mode

6.3.16 RCC APB2 peripheral clock enabled in low power mode register (RCC_APB2LPENR)

Address offset: 0x64

Reset value: 0x0007 7930

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved													TIM11 LPEN	TIM10 LPEN	TIM9 LPEN
													rw	rw	rw

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reser-ved	SYSCFG LPEN	SPI4LP EN	SPI1 LPEN	SDIO LPEN	Reserved		ADC1 LPEN	Reserved		USART6 LPEN	USART1 LPEN	Reserved			TIM1 LPEN
	rw	rw	rw	rw			rw			rw	rw				rw

Bits 31:19 Reserved, must be kept at reset value.

Bit 18 **TIM11LPEN:** TIM11 clock enable during Sleep mode
Set and cleared by software.
0: TIM11 clock disabled during Sleep mode
1: TIM11 clock enabled during Sleep mode

Bit 17 **TIM10LPEN:** TIM10 clock enable during Sleep mode
Set and cleared by software.
0: TIM10 clock disabled during Sleep mode
1: TIM10 clock enabled during Sleep mode

Bit 16 **TIM9LPEN:** TIM9 clock enable during sleep mode
Set and cleared by software.
0: TIM9 clock disabled during Sleep mode
1: TIM9 clock enabled during Sleep mode

Bit 15 Reserved, must be kept at reset value.

Bit 14 **SYSCFGLPEN:** System configuration controller clock enable during Sleep mode
Set and cleared by software.
0: System configuration controller clock disabled during Sleep mode
1: System configuration controller clock enabled during Sleep mode

Bit 13 **SPI4LPEN:** SPI4 clock enable during sleep mode
Set and reset by software.
0: SPI4 clock disabled during sleep mode
1: SPI4 clock enabled during sleep mode

Bit 12 **SPI1LPEN:** SPI1 clock enable during Sleep mode
Set and cleared by software.
0: SPI1 clock disabled during Sleep mode
1: SPI1 clock enabled during Sleep mode

Bit 11 **SDIOLPEN:** SDIO clock enable during Sleep mode
Set and cleared by software.
0: SDIO module clock disabled during Sleep mode
1: SDIO module clock enabled during Sleep mode

Bits 10:9 Reserved, must be kept at reset value.

Bit 8 **ADC1LPEN:** ADC1 clock enable during Sleep mode
Set and cleared by software.
0: ADC1 clock disabled during Sleep mode
1: ADC1 clock disabled during Sleep mode

Bits 7:6 Reserved, must be kept at reset value.

Bit 5 **USART6LPEN:** USART6 clock enable during Sleep mode
Set and cleared by software.
0: USART6 clock disabled during Sleep mode
1: USART6 clock enabled during Sleep mode

Bit 4 **USART1LPEN:** USART1 clock enable during Sleep mode
Set and cleared by software.
0: USART1 clock disabled during Sleep mode
1: USART1 clock enabled during Sleep mode

Bits 3:1 Reserved, must be kept at reset value.

Bit 0 **TIM1LPEN:** TIM1 clock enable during Sleep mode
Set and cleared by software.
0: TIM1 clock disabled during Sleep mode
1: TIM1 clock enabled during Sleep mode

6.3.17 RCC Backup domain control register (RCC_BDCR)

Address offset: 0x70

Reset value: 0x0000 0000, reset by Backup domain reset.
Access: 0 ≤ wait state ≤ 3, word, half-word and byte access
Wait states are inserted in case of successive accesses to this register.

The LSEON, LSEBYP, RTCSEL and RTCEN bits in the *RCC Backup domain control register (RCC_BDCR)* are in the Backup domain. As a result, after Reset, these bits are write-protected and the DBP bit in the *PWR power control register (PWR_CR)* has to be set before these can be modified. Refer to *Section 5.1.2 on page 72* for further information. These bits are only reset after a Backup domain Reset (see *Section 6.1.3: Backup domain reset*). Any internal or external Reset will not have any effect on these bits.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved															BDRST
															rw

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RTCEN	Reserved					RTCSEL[1:0]		Reserved					LSEBYP	LSERDY	LSEON
rw						rw	rw						rw	r	rw

Bits 31:17 Reserved, must be kept at reset value.

Bit 16 **BDRST:** Backup domain software reset
Set and cleared by software.
0: Reset not activated
1: Resets the entire Backup domain

Bit 15 **RTCEN:** RTC clock enable
Set and cleared by software.
0: RTC clock disabled
1: RTC clock enabled

Bits 14:10 Reserved, must be kept at reset value.

Bits 9:8 **RTCSEL[1:0]:** RTC clock source selection
Set by software to select the clock source for the RTC. Once the RTC clock source has been selected, it cannot be changed anymore unless the Backup domain is reset. The BDRST bit can be used to reset them.
00: No clock
01: LSE oscillator clock used as the RTC clock
10: LSI oscillator clock used as the RTC clock
11: HSE oscillator clock divided by a programmable prescaler (selection through the RTCPRE[4:0] bits in the RCC clock configuration register (RCC_CFGR)) used as the RTC clock

Bits 7:3 Reserved, must be kept at reset value.

Bit 2 **LSEBYP:** External low-speed oscillator bypass
Set and cleared by software to bypass oscillator in debug mode. This bit can be written only when the LSE clock is disabled.
0: LSE oscillator not bypassed
1: LSE oscillator bypassed

Bit 1 **LSERDY:** External low-speed oscillator ready

Set and cleared by hardware to indicate when the external 32 kHz oscillator is stable. After the LSEON bit is cleared, LSERDY goes low after 6 external low-speed oscillator clock cycles.
0: LSE clock not ready
1: LSE clock ready

Bit 0 **LSEON:** External low-speed oscillator enable

Set and cleared by software.
0: LSE clock OFF
1: LSE clock ON

6.3.18 RCC clock control & status register (RCC_CSR)

Address offset: 0x74

Reset value: 0x0E00 0000, reset by system reset, except reset flags by power reset only.

Access: 0 ≤ wait state ≤ 3, word, half-word and byte access

Wait states are inserted in case of successive accesses to this register.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
LPWR RSTF	WWDG RSTF	IWDG RSTF	SFT RSTF	POR RSTF	PIN RSTF	BORRS TF	RMVF	Reserved							
r	r	r	r	r	r	r	rt_w								
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved														LSIRDY	LSION
														r	rw

Bit 31 **LPWRRSTF:** Low-power reset flag

Set by hardware when a Low-power management reset occurs.
Cleared by writing to the RMVF bit.
0: No Low-power management reset occurred
1: Low-power management reset occurred
For further information on Low-power management reset, refer to *Low-power management reset*.

Bit 30 **WWDGRSTF:** Window watchdog reset flag

Set by hardware when a window watchdog reset occurs.
Cleared by writing to the RMVF bit.
0: No window watchdog reset occurred
1: Window watchdog reset occurred

Bit 29 **IWDGRSTF:** Independent watchdog reset flag

Set by hardware when an independent watchdog reset from V_{DD} domain occurs.
Cleared by writing to the RMVF bit.
0: No watchdog reset occurred
1: Watchdog reset occurred

Bit 28 **SFTRSTF:** Software reset flag

Set by hardware when a software reset occurs.
Cleared by writing to the RMVF bit.
0: No software reset occurred
1: Software reset occurred

Bit 27 **PORRSTF:** POR/PDR reset flag
Set by hardware when a POR/PDR reset occurs.
Cleared by writing to the RMVF bit.
0: No POR/PDR reset occurred
1: POR/PDR reset occurred

Bit 26 **PINRSTF:** PIN reset flag
Set by hardware when a reset from the NRST pin occurs.
Cleared by writing to the RMVF bit.
0: No reset from NRST pin occurred
1: Reset from NRST pin occurred

Bit 25 **BORRSTF:** BOR reset flag
Cleared by software by writing the RMVF bit.
Set by hardware when a POR/PDR or BOR reset occurs.
0: No POR/PDR or BOR reset occurred
1: POR/PDR or BOR reset occurred

Bit 24 **RMVF:** Remove reset flag
Set by software to clear the reset flags.
0: No effect
1: Clear the reset flags

Bits 23:2 Reserved, must be kept at reset value.

Bit 1 **LSIRDY:** Internal low-speed oscillator ready
Set and cleared by hardware to indicate when the internal RC 40 kHz oscillator is stable. After the LSION bit is cleared, LSIRDY goes low after 3 LSI clock cycles.
0: LSI RC oscillator not ready
1: LSI RC oscillator ready

Bit 0 **LSION:** Internal low-speed oscillator enable
Set and cleared by software.
0: LSI RC oscillator OFF
1: LSI RC oscillator ON

6.3.19 RCC spread spectrum clock generation register (RCC_SSCGR)

Address offset: 0x80

Reset value: 0x0000 0000

Access: no wait state, word, half-word and byte access.

The spread spectrum clock generation is available only for the main PLL.

The RCC_SSCGR register must be written either before the main PLL is enabled or after the main PLL disabled.

Note: For full details about PLL spread spectrum clock generation (SSCG) characteristics, refer to the "Electrical characteristics" section in your device datasheet.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
SSCGEN	SPREADSEL	Reserved		INCSTEP											
rw	rw			rw	rw	rw		rw	rw	rw	rw	rw	rw	rw	rw

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
INCSTEP			MODPER												
rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw

Bit 31 **SSCGEN:** Spread spectrum modulation enable
Set and cleared by software.
0: Spread spectrum modulation DISABLE. (To write after clearing CR[24]=PLLON bit)
1: Spread spectrum modulation ENABLE. (To write before setting CR[24]=PLLON bit)

Bit 30 **SPREADSEL:** Spread Select
Set and cleared by software.
To write before to set CR[24]=PLLON bit.
0: Center spread
1: Down spread

Bits 29:28 Reserved, must be kept at reset value.

Bits 27:13 **INCSTEP:** Incrementation step
Set and cleared by software. To write before setting CR[24]=PLLON bit.
Configuration input for modulation profile amplitude.

Bits 12:0 **MODPER:** Modulation period
Set and cleared by software. To write before setting CR[24]=PLLON bit.
Configuration input for modulation profile period.

6.3.20 RCC PLLI2S configuration register (RCC_PLLI2SCFGR)

Address offset: 0x84

Reset value: 0x2400 3000

Access: no wait state, word, half-word and byte access.

This register is used to configure the PLLI2S clock outputs according to the formulas:

- $f_{(VCO\ clock)} = f_{(PLLI2S\ clock\ input)} \times (PLLI2SN / PLLM)$
- $f_{(PLL\ I2S\ clock\ output)} = f_{(VCO\ clock)} / PLLI2SR$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved	PLLI2SR2	PLLI2SR1	PLLI2SR0	Reserved											
	rw	rw	rw												

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved	PLLI2SN8	PLLI2SN7	PLLI2SN6	PLLI2SN5	PLLI2SN4	PLLI2SN3	PLLI2SN2	PLLI2SN1	PLLI2SN0	Reserved					
	rw	rw	rw	rw	rw	rw	rw	rw	rw						

Bit 31 Reserved, must be kept at reset value.

Bits 30:28 **PLLI2SR:** PLLI2S division factor for I2S clocks

Set and cleared by software to control the I2S clock frequency. These bits should be written only if the PLLI2S is disabled. The factor must be chosen in accordance with the prescaler values inside the I2S peripherals, to reach 0.3% error when using standard crystals and 0% error with audio crystals. For more information about I2S clock frequency and precision, refer to *Section 20.4.4: Clock generator* in the I2S chapter.

Caution: The I2Ss requires a frequency lower than or equal to 192 MHz to work correctly.

I2S clock frequency = VCO frequency / PLLR with $2 \leq PLLR \leq 7$

000: PLLR = 0, wrong configuration

001: PLLR = 1, wrong configuration

010: PLLR = 2

...

111: PLLR = 7

Bits 27:15 Reserved, must be kept at reset value.

Bits 14:6 **PLLI2SN:** PLLI2S multiplication factor for VCO

Set and cleared by software to control the multiplication factor of the VCO. These bits can be written only when the PLLI2S is disabled. Only half-word and word accesses are allowed to write these bits.

Caution: The software has to set these bits correctly to ensure that the VCO output frequency is between 192 and 432 MHz. With VCO input frequency ranges from 1 to 2 MHz (refer to *Figure 13* and divider factor M of the *RCC PLL configuration register (RCC_PLLCFGR)*)

VCO output frequency = VCO input frequency × PLLI2SN with 192 ≤PLLI2SN ≤432

000000000: PLLI2SN = 0, wrong configuration
000000001: PLLI2SN = 1, wrong configuration
...
011000000: PLLI2SN = 192
011000001: PLLI2SN = 193
011000010: PLLI2SN = 194

...
110110000: PLLI2SN = 432
110110000: PLLI2SN = 433, wrong configuration
...
111111111: PLLI2SN = 511, wrong configuration

Bits 5:0 Reserved, must be kept at reset value.

6.3.21 RCC Dedicated Clocks Configuration Register (RCC_DCKCFGR)

Address offset: 0x8C

Reset value: 0x0000 0000

Access: no wait state, word, half-word and byte access.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved							TIMPRE	Reserved							
							rw								
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved															

Bits 31:25 Reserved, must be kept at reset value.

Bit 24 **TIMPRE**: Timers clocks prescalers selection

Set and reset by software to control the clock frequency of all the timers connected to APB1 and APB2 domain.

0: If the APB prescaler (PPRE1, PPRE2 in the RCC_CFGR register) is configured to a division factor of 1, TIMxCLK = HCKL . Otherwise, the timer clock frequencies are set to twice to the frequency of the APB domain to which the timers are connected: TIMxCLK = 2xPCLKx.

1:If the APB prescaler (PPRE1, PPRE2 in the RCC_CFGR register) is configured to a division factor of 1 or 2, TIMxCLK = HCKL. Otherwise, the timer clock frequencies are set to four times to the frequency of the APB domain to which the timers are connected: TIMxCLK = 4xPCLKx.

Bits 23: 0 Reserved, must be kept at reset value.

6.3.22 RCC register map

Table 22 gives the register map and reset values

Table 22. RCC register map and reset values for STM32F401xB/C and STM32F401xD/E

Addr. offset	Register name	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x00	RCC_CR	Reserved				PLL I2SRDY	PLL I2SON	PLL RDY	PLL ON	Reserved				CSSON	HSEBYP	HSERDY	HSEON	HSICAL 7	HSICAL 6	HSICAL 5	HSICAL 4	HSICAL 3	HSICAL 2	HSICAL 1	HSICAL 0	HSITRIM 4	HSITRIM 3	HSITRIM 2	HSITRIM 1	HSITRIM 0	Reserved	HSIRDY	HSION
0x04	RCC_PLLCFGR	Reserved				PLLQ 3	PLLQ 2	PLLQ 1	PLLQ 0	Reserved	PLLSRC	Reserved				PLLP 1	PLLP 0	Reserved	PLLN 8	PLLN 7	PLLN 6	PLLN 5	PLLN 4	PLLN 3	PLLN 2	PLLN 1	PLLN 0	PLLM 5	PLLM 4	PLLM 3	PLLM 2	PLLM 1	PLLM 0
0x08	RCC_CFGR	MCO2 1	MCO2 0	MCO2PRE2	MCO2PRE1	MCO2PRE0	MCO1PRE2	MCO1PRE1	MCO1PRE0	I2SSRC	MCO1 1	MCO1 0	RTCPRE 4	RTCPRE 3	RTCPRE 2	RTCPRE 1	RTCPRE 0	PPRE2 2	PPRE2 1	PPRE2 0	PPRE1 2	PPRE1 1	PPRE1 0	Reserved		HPRE 3	HPRE 2	HPRE 1	HPRE 0	SWS 1	SWS 0	SW 1	SW 0	
0x0C	RCC_CIR	Reserved								CSSC	Reserved	PLLI2SRDYC	PLLRDYC	HSERDYC	HSIRDYC	LSERDYC	LSIRDYC	Reserved	PLLI2SRDYIE	PLLRDYIE	HSERDYIE	HSIRDYIE	LSERDYIE	LSIRDYIE	CSSF	Reserved	PLLI2SRDYF	PLLRDYF	HSERDYF	HSIRDYF	LSERDYF	LSIRDYF	
0x10	RCC_AHB1RSTR	Reserved									DMA2RST	DMA1RST	Reserved								CRCRST	Reserved				GPIOHRST	Reserved		GPIOERST	GPIODRST	GPIOCRST	GPIOBRST	GPIOARST
0x14	RCC_AHB2RSTR	Reserved																								OTGFSRST	Reserved						
0x18	Reserved	Reserved																															
0x1C	Reserved	Reserved																															
0x20	RCC_APB1RSTR	Reserved			PWRRST	Reserved				I2C3RST	I2C2RST	I2C1RST	Reserved			USART2RST	Reserved	SPI3RST	SPI2RST	Reserved		WWDGRST	Reserved							TIM5RST	TIM4RST	TIM3RST	TIM2RST
0x24	RCC_APB2RSTR	Reserved													TIM11RST	TIM10RST	TIM9RST	Reserved	SYSCFGRST	SP45RST	SPI1RST	SDIORST	Reserved	ADC1RST	Reserved			USART6RST	USART1RST	Reserved				TIM1RST
0x28	Reserved	Reserved																															
0x2C	Reserved	Reserved																															
0x30	RCC_AHB1ENR	Reserved									DMA2EN	DMA1EN	Reserved								CRCEN	Reserved				GPIOHEN	Reserved		GPIOEEN	GPIODEN	GPIOCEN	GPIOBEN	GPIOAEN
0x34	RCC_AHB2ENR	Reserved																								OTGFSEN	Reserved						
0x38	Reserved	Reserved																															
0x3C	Reserved	Reserved																															

Table 22. RCC register map and reset values for STM32F401xB/C and STM32F401xD/E (continued)

Addr. offset	Register name	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x40	RCC_APB1ENR	Reserved			PWREN	Reserved				I2C3EN	I2C2EN	I2C1EN	Reserved			USART2EN	Reserved	SPI3EN	SPI2EN	Reserved		WWDGEN	Reserved							TIM5EN	TIM4EN	TIM3EN	TIM2EN
0x44	RCC_APB2ENR	Reserved													TIM11EN	TIM10EN	TIM9EN	Reserved	SYSCFGEN	SPI4EN	SPI1EN	SDIOEN	Reserved		ADC1EN	Reserved		USART6EN	USART1EN	Reserved				TIM1EN
0x48	Reserved	Reserved																															
0x4C	Reserved	Reserved																															
0x50	RCC_AHB1LPENR	Reserved									DMA2LPEN	DMA1LPEN	Reserved				SRAM1LPEN	FLITFLPEN	Reserved	CRCLPEN	Reserved				GPIOHLPEN	Reserved		GPIOELPEN	GPIODLPEN	GPIOCLPEN	GPIOBLPEN	GPIOALPEN
0x54	RCC_AHB2LPENR	Reserved																								OTGFSLPEN	Reserved						
0x58	Reserved	Reserved																															
0x5C	Reserved	Reserved																															
0x60	RCC_APB1LPENR	Reserved			PWRLPEN	Reserved				I2C3LPEN	I2C2LPEN	I2C1LPEN	Reserved			USART2LPEN	Reserved	SPI3LPEN	SPI2LPEN	Reserved		WWDGLPEN	Reserved							TIM5LPEN	TIM4LPEN	TIM3LPEN	TIM2LPEN
0x64	RCC_APB2LPENR	Reserved													TIM11LPEN	TIM10LPEN	TIM9LPEN	Reserved	SYSCFGLPEN	SPI4LPEN	SPI1LPEN	SDIOLPEN	Reserved		ADC1LPEN	Reserved		USART6LPEN	USART1LPEN	Reserved				TIM1LPEN
0x68	Reserved	Reserved																															
0x6C	Reserved	Reserved																															
0x70	RCC_BDCR	Reserved															BDRST	RTCEN	Reserved				RTCSEL 1	RTCSEL 0	Reserved					LSEBYP	LSERDY	LSEON
0x74	RCC_CSR	LPWRRSTF	WWDGRSTF	WDGRSTF	SFTRSTF	PORRSTF	PADRSTF	BORRSTF	RMVF	Reserved																						LSIRDY	LSION
0x78	Reserved	Reserved																															
0x7C	Reserved	Reserved																															
0x80	RCC_SSCGR	SSCGEN	SPREADSEL	Reserved						INCSTEP																							
0x84	RCC_PLLI2SCFGR	Reserved	PLLI2SRx							Reserved													PLLI2SNx							Reserved			

Table 22. RCC register map and reset values for STM32F401xB/C and STM32F401xD/E (continued)

Addr. offset	Register name	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x88	Reserved																																
0x8C	RCC_DCKCFGR	Reserved							TIMPRE	Reserved																							

Refer to *Table 1* for the register boundary addresses.