

21 Independent watchdog (IWDG)

This section applies to the whole STM32F4xx family, unless otherwise specified.

21.1 IWDG introduction

The devices have two embedded watchdog peripherals which offer a combination of high safety level, timing accuracy and flexibility of use. Both watchdog peripherals (Independent and Window) serve to detect and resolve malfunctions due to software failure, and to trigger system reset or an interrupt (window watchdog only) when the counter reaches a given timeout value.

The independent watchdog (IWDG) is clocked by its own dedicated low-speed clock (LSI) and thus stays active even if the main clock fails. The window watchdog (WWDG) clock is prescaled from the APB1 clock and has a configurable time-window that can be programmed to detect abnormally late or early application behavior.

The IWDG is best suited to applications which require the watchdog to run as a totally independent process outside the main application, but have lower timing accuracy constraints. The WWDG is best suited to applications which require the watchdog to react within an accurate timing window. For further information on the window watchdog, refer to [Section 22 on page 716](#).

21.2 IWDG main features

- Free-running downcounter
- clocked from an independent RC oscillator (can operate in Standby and Stop modes)
- Reset (if watchdog activated) when the downcounter value of 0x000 is reached

21.3 IWDG functional description

[Figure 213](#) shows the functional blocks of the independent watchdog module.

When the independent watchdog is started by writing the value 0xCCCC in the Key register (IWDG_KR), the counter starts counting down from the reset value of 0xFFFF. When it reaches the end of count value (0x000) a reset signal is generated (IWDG reset).

Whenever the key value 0xAAAA is written in the IWDG_KR register, the IWDG_RLR value is reloaded in the counter and the watchdog reset is prevented.

21.3.1 Hardware watchdog

If the “Hardware watchdog” feature is enabled through the device option bits, the watchdog is automatically enabled at power-on, and generates a reset unless the Key register is written by the software before the counter reaches end of count.

21.3.2 Register access protection

Write access to the IWDG_PR and IWDG_RLR registers is protected. To modify them, first write the code 0x5555 in the IWDG_KR register. A write access to this register with a

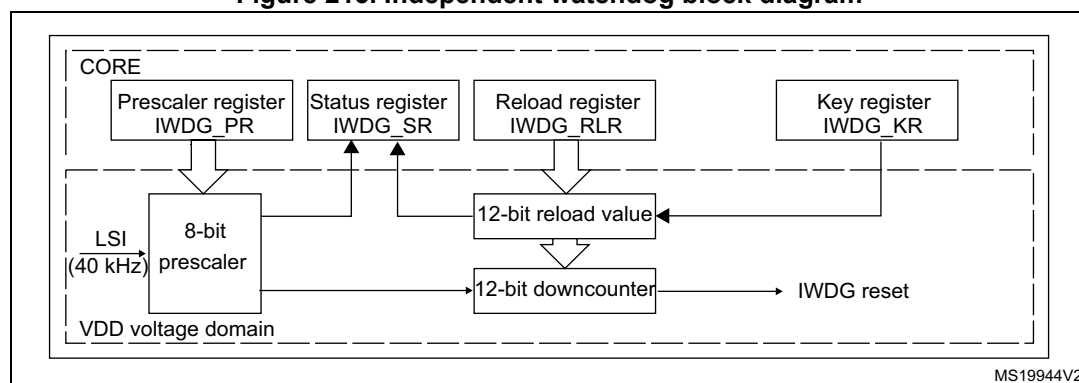
different value breaks the sequence and register access is protected again. This implies that it is the case of the reload operation (writing 0xAAAA).

A status register is available to indicate that an update of the prescaler or the down-counter reload value is on going.

21.3.3 Debug mode

When the microcontroller enters debug mode (Cortex[®]-M4 with FPU core halted), the IWDG counter either continues to work normally or stops, depending on DBG_IWDG_STOP configuration bit in DBG module. For more details, refer to [Section 38.16.2: Debug support for timers, watchdog, bxCAN and I²C](#).

Figure 213. Independent watchdog block diagram



Note: The watchdog function is implemented in the V_{DD} voltage domain, still functional in Stop and Standby modes.

Table 108. Min/max IWDG timeout period (in ms) at 32 kHz (LSI)⁽¹⁾

Prescaler divider	PR[2:0] bits	Min timeout RL[11:0]= 0x000	Max timeout RL[11:0]= 0xFFFF
/4	0	0.125	512
/8	1	0.25	1024
/16	2	0.5	2048
/32	3	1	4096
/64	4	2	8192
/128	5	4	16384
/256	6	8	32768

1. These timings are given for a 32 kHz clock but the microcontroller internal RC frequency can vary. Refer to the LSI oscillator characteristics table in the device datasheet for maximum and minimum values.

21.4 IWDG registers

Refer to [Section 2.2 on page 45](#) for a list of abbreviations used in register descriptions.

The peripheral registers have to be accessed by half-words (16 bits) or words (32 bits).

21.4.1 Key register (IWDG_KR)

Address offset: 0x00

Reset value: 0x0000 0000 (reset by Standby mode)

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
Reserved																KEY[15:0]															
																w	w	w	w	w	w	w	w	w	w	w	w	w	w	w	w

Bits 31:16 Reserved, must be kept at reset value.

Bits 15:0 **KEY[15:0]**: Key value (write only, read 0000h)

These bits must be written by software at regular intervals with the key value AAAAh, otherwise the watchdog generates a reset when the counter reaches 0.

Writing the key value 5555h to enable access to the IWDG_PR and IWDG_RLR registers (see [Section 21.3.2](#))

Writing the key value CCCCh starts the watchdog (except if the hardware watchdog option is selected)

21.4.2 Prescaler register (IWDG_PR)

Address offset: 0x04

Reset value: 0x0000 0000

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	
Reserved																														PR[2:0]		
																														r/w	r/w	r/w

Bits 31:3 Reserved, must be kept at reset value.

Bits 2:0 **PR[2:0]**: Prescaler divider

These bits are write access protected see [Section 21.3.2](#). They are written by software to select the prescaler divider feeding the counter clock. PVU bit of IWDG_SR must be reset in order to be able to change the prescaler divider.

000: divider /4

001: divider /8

010: divider /16

011: divider /32

100: divider /64

101: divider /128

110: divider /256

111: divider /256

Note: Reading this register returns the prescaler value from the VDD voltage domain. This value may not be up to date/valid if a write operation to this register is ongoing. For this reason the value read from this register is valid only when the PVU bit in the IWDG_SR register is reset.

21.4.3 Reload register (IWDG_RLR)

Address offset: 0x08

Reset value: 0x0000 0FFF (reset by Standby mode)

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
Reserved																				RL[11:0]											
																				rW	rW	rW	rW	rW	rW	rW	rW	rW	rW	rW	rW

Bits 31:12 Reserved, must be kept at reset value.

Bits11:0 **RL[11:0]**: Watchdog counter reload value

These bits are write access protected see [Section 21.3.2](#). They are written by software to define the value to be loaded in the watchdog counter each time the value AAAAh is written in the IWDG_KR register. The watchdog counter counts down from this value. The timeout period is a function of this value and the clock prescaler. Refer to [Table 108](#).

The RVU bit in the IWDG_SR register must be reset in order to be able to change the reload value.

Note: Reading this register returns the reload value from the VDD voltage domain. This value may not be up to date/valid if a write operation to this register is ongoing on this register. For this reason the value read from this register is valid only when the RVU bit in the IWDG_SR register is reset.

21.4.4 Status register (IWDG_SR)

Address offset: 0x0C

Reset value: 0x0000 0000 (not reset by Standby mode)

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
Reserved																											RVU	PVU			
																											r	r			

Bits 31:2 Reserved, must be kept at reset value.

Bit 1 **RVU**: Watchdog counter reload value update

This bit is set by hardware to indicate that an update of the reload value is ongoing. It is reset by hardware when the reload value update operation is completed in the V_{DD} voltage domain (takes up to 5 RC 40 kHz cycles).

Reload value can be updated only when RVU bit is reset.

Bit 0 **PVU**: Watchdog prescaler value update

This bit is set by hardware to indicate that an update of the prescaler value is ongoing. It is reset by hardware when the prescaler update operation is completed in the V_{DD} voltage domain (takes up to 5 RC 40 kHz cycles).

Prescaler value can be updated only when PVU bit is reset.

Note: If several reload values or prescaler values are used by application, it is mandatory to wait until RVU bit is reset before changing the reload value and to wait until PVU bit is reset before changing the prescaler value. However, after updating the prescaler and/or the reload value it is not necessary to wait until RVU or PVU is reset before continuing code execution (even in case of low-power mode entry, the write operation is taken into account and completes)

21.4.5 IWDG register map

The following table gives the IWDG register map and reset values.

Table 109. IWDG register map and reset values

Offset	Register	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	IWDG_KR	Reserved																KEY[15:0]															
	Reset value																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0x04	IWDG_PR	Reserved																												PR[2:0]			
	Reset value																													0	0	0	
0x08	IWDG_RLR	Reserved																RL[11:0]															
	Reset value																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0x0C	IWDG_SR	Reserved																												RVU		PVU	
	Reset value																													0	0	0	

Refer to [Section 2.3: Memory map](#) for the register boundary addresses.