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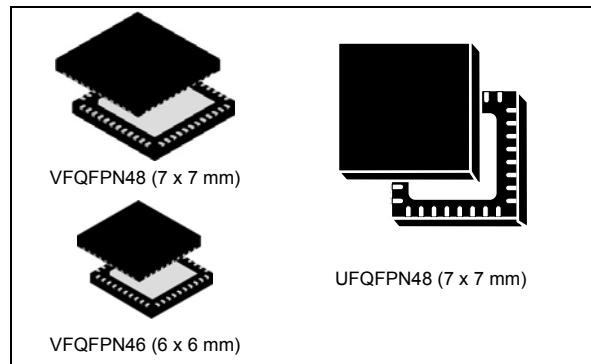


High-performance, IEEE 802.15.4 wireless system-on-chip with up to 256 Kbyte of embedded Flash memory

Datasheet - not recommended for new design

Features

- Complete system-on-chip
 - 32-bit ARM[®] Cortex[®]-M3 processor
 - 2.4 GHz IEEE 802.15.4 transceiver and lower MAC
 - 128/192/256-Kbyte Flash, 8/12/16-Kbyte RAM memory
 - AES128 encryption accelerator
 - Flexible ADC, SPI/UART/I²C serial communications, and general-purpose timers
 - 24 highly configurable GPIOs with Schmitt trigger inputs
- Industry-leading ARM[®] Cortex[®]-M3 processor
 - Leading 32-bit processing performance
 - Highly efficient Thumb[®]-2 instruction set
 - Operation at 6, 12 or 24 MHz
 - Flexible nested vectored interrupt controller
- Low power consumption, advanced management
 - Receive current (w/ CPU): 27 mA
 - Transmit current (w/ CPU, +3 dBm TX): 31 mA
 - Low deep sleep current, with retained RAM and GPIO: 400 nA/800 nA with/without sleep timer
 - Low-frequency internal RC oscillator for low-power sleep timing
 - High-frequency internal RC oscillator for fast (100 μs) processor start-up from sleep
- Exceptional RF performance
 - Normal mode link budget up to 102 dB; configurable up to 107 dB
 - -99 dBm normal RX sensitivity; configurable to -100 dBm (1% PER, 20 byte packet)
 - +3 dB normal mode output power; configurable up to +8 dBm



- Robust WiFi and Bluetooth coexistence
- Innovative network and processor debug
 - Non-intrusive hardware packet trace
 - Serial wire/JTAG interface
 - Standard ARM debug capabilities: Flash patch and breakpoint; data watchpoint and trace; instrumentation trace macrocell
- Application flexibility
 - Single voltage operation: 2.1-3.6 V with internal 1.8 V and 1.25 V regulators
 - Optional 32.768 kHz crystal for higher timer accuracy
 - Low external component count with single 24 MHz crystal
 - Support for external power amplifier
 - Small 7x7 mm 48-pin VFQFPN and UFQFPN packages or 6x6 mm 40-pin VFQFPN package

Applications

- Smart energy
- Building automation and control
- Home automation and control
- Security and monitoring
- ZigBee[®] Pro wireless sensor networking
- RF4CE products and remote controls

Contents

1	Description	14
1.1	Development tools	15
1.2	Overview	16
1.2.1	Functional description	16
1.2.2	ARM® Cortex®-M3 core	17
2	Documentation conventions	18
3	Pinout and pin description	19
4	Embedded memory	31
4.1	Memory organization and memory map	31
4.2	Flash memory	35
4.3	Random-access memory	36
4.3.1	Direct memory access (DMA) to RAM	36
4.3.2	RAM memory protection	37
4.3.3	Memory controller	37
4.3.4	Memory controller registers	38
4.4	Memory protection unit	42
5	Radio frequency module	43
5.1	Receive (Rx) path	43
5.1.1	Rx baseband	43
5.1.2	RSSI and CCA	43
5.2	Transmit (Tx) path	44
5.2.1	Tx baseband	44
5.2.2	TX_ACTIVE and nTX_ACTIVE signals	44
5.3	Calibration	44
5.4	Integrated MAC module	44
5.5	Packet trace interface (PTI)	45
5.6	Random number generator	45
6	System modules	46

6.1	Power domains	47
6.1.1	Internally regulated power	47
6.1.2	Externally regulated power	47
6.2	Resets	48
6.2.1	Reset sources	48
6.2.2	Reset recording	49
6.2.3	Reset generation	50
6.2.4	Reset register	51
6.3	Clocks	53
6.3.1	High-frequency internal RC oscillator (HSI)	55
6.3.2	High-frequency crystal oscillator (HSE OSC)	55
6.3.3	Low-frequency internal RC oscillator (LSI10K)	55
6.3.4	Low-frequency crystal oscillator (LSE OSC)	55
6.3.5	Clock switching	56
6.3.6	Clock switching registers	57
6.4	System timers	64
6.4.1	MAC timer	64
6.4.2	Watchdog timer	64
6.4.3	Sleep timer	64
6.4.4	Event timer	65
6.4.5	Slow timer (MAC timer, Watchdog, and Sleptimer) control and status registers	65
6.5	Power management	74
6.5.1	Wake sources	74
6.5.2	Basic sleep modes	76
6.5.3	Further options for deep sleep	77
6.5.4	Use of debugger with sleep modes	77
6.5.5	Power management registers	78
6.6	Security accelerator	89
7	Integrated voltage regulator	90
8	General-purpose input/output	92
8.1	Functional description	93
8.1.1	GPIO ports	93
8.1.2	Configuration	94
8.1.3	Forced functions	95

8.1.4	Reset	95
8.1.5	nBOOTMODE	96
8.1.6	GPIO modes	96
8.1.7	Wake monitoring	98
8.2	External interrupts	98
8.3	Debug control and status	99
8.4	GPIO alternate functions	99
8.5	General-purpose input/output (GPIO) registers	101
8.5.1	Port x configuration register (Low) (GPIOx_CRL)	101
8.5.2	Port x configuration register (High) (GPIOx_CRH)	102
8.5.3	Port x input data register (GPIOx_IDR)	103
8.5.4	Port x output data register (GPIOx_ODR)	103
8.5.5	Port x output set register (GPIOx_BSR)	104
8.5.6	Port x output clear register (GPIOx_BRR)	104
8.5.7	External interrupt pending register (EXTI_PR)	105
8.5.8	External interrupt x trigger selection register (EXTIx_TSR)	105
8.5.9	External interrupt x configuration register (EXTIx_CR)	106
8.5.10	PC TRACE or debug select register (GPIO_PCTRACECR)	106
8.5.11	GPIO debug configuration register (GPIO_DBGCR)	107
8.5.12	GPIO debug status register (GPIO_DBGSR)	107
8.5.13	General-purpose input/output (GPIO) register map	108
9	Serial interfaces	110
9.1	Functional description	110
9.2	Configuration	111
9.3	SPI master mode	112
9.3.1	Setup and configuration	113
9.3.2	Operation	114
9.3.3	Interrupts	115
9.4	SPI slave mode	116
9.4.1	Setup and configuration	116
9.4.2	Operation	117
9.4.3	DMA	118
9.4.4	Interrupts	119
9.5	Inter-integrated circuit interfaces (I2C)	119
9.5.1	Setup and configuration	120

9.5.2	Constructing frames	120
9.5.3	Interrupts	123
9.6	Universal asynchronous receiver/transmitter (UART)	123
9.6.1	Setup and configuration	124
9.6.2	FIFOs	125
9.6.3	RTS/CTS flow control	126
9.6.4	DMA	127
9.6.5	Interrupts	127
9.7	Direct memory access (DMA) channels	127
9.8	Serial controller common registers	129
9.8.1	Serial controller interrupt status register (SCx_ISR)	129
9.8.2	Serial controller interrupt enable register (SCx_IER)	131
9.8.3	Serial controller interrupt control register 1 (SCx_ICR)	133
9.8.4	Serial controller data register (SCx_DR)	134
9.8.5	Serial controller control register 2 (SCx_CR)	134
9.8.6	Serial controller clock rate register 1 (SCx_CRR1)	135
9.8.7	Serial controller clock rate register 2 (SCx_CRR2)	135
9.9	Serial controller: Serial peripheral interface (SPI) registers	136
9.9.1	Serial controller SPI status register (SCx_SPI_SR)	136
9.9.2	Serial controller SPI control register (SCx_SPI_CR)	137
9.10	Serial controller: Inter-integrated circuit (I2C) registers	138
9.10.1	Serial controller I2C status register (SCx_I2C_SR)	138
9.10.2	Serial controller I2C control register 1 (SCx_I2C_CR1)	139
9.10.3	Serial controller I2C control register 2 (SCx_I2C_CR2)	140
9.11	Serial controller: Universal asynchronous receiver/ transmitter (UART) registers	141
9.11.1	Serial controller UART status register (SC1_UART_SR)	141
9.11.2	Serial controller UART control register (SC1_UART_CR)	142
9.11.3	Serial controller UART baud rate register 1 (SC1_UART_BRR1)	143
9.11.4	Serial controller UART baud rate register 2 (SC1_UART_BRR2)	144
9.12	Serial controller: Direct memory access (DMA) registers	145
9.12.1	Serial controller receive DMA begin address channel A register (SCx_DMARXBEGADDAR)	145
9.12.2	Serial controller receive DMA end address channel A register (SCx_DMARXENDADDAR)	145
9.12.3	Serial controller receive DMA begin address channel B register (SCx_DMARXBEGADDBR)	146

- 9.12.4 Serial controller receive DMA end address channel B register (SCx_DMARXENDADDBR) 146
- 9.12.5 Serial controller transmit DMA begin address channel A register (SCx_DMATXBEGADDAR) 147
- 9.12.6 Serial controller transmit DMA end address channel A register (SCx_DMATXENDADDAR) 147
- 9.12.7 Serial controller transmit DMA begin address channel B register (SCx_DMATXBEGADDBR) 148
- 9.12.8 Serial controller transmit DMA end address channel B register (SCx_DMATXENDADDBR) 148
- 9.12.9 Serial controller receive DMA counter channel A register (SCx_DMARXCNTAR) 149
- 9.12.10 Serial controller receive DMA count channel B register (SCx_DMARXCNTBR) 149
- 9.12.11 Serial controller transmit DMA counter register (SCx_DMATXCNTR) 150
- 9.12.12 Serial controller DMA status register (SCx_DMASR) 151
- 9.12.13 Serial controller DMA control register (SCx_DMACR) 153
- 9.12.14 Serial controller receive DMA channel A first error register (SCx_DMARXERRAR) 154
- 9.12.15 Serial controller receive DMA channel B first error register (SCx_DMARXERRBR) 154
- 9.12.16 Serial controller receive DMA saved counter channel B register (SCx_DMARXCNTSAVEDR) 155
- 9.12.17 Serial interface (SC1/SC2) register map 155

10 General-purpose timers 160

- 10.1 Functional description 162
 - 10.1.1 Time-base unit 162
 - 10.1.2 Counter modes 164
 - 10.1.3 Clock selection 170
 - 10.1.4 Capture/compare channels 173
 - 10.1.5 Input capture mode 175
 - 10.1.6 PWM input mode 176
 - 10.1.7 Forced output mode 177
 - 10.1.8 Output compare mode 177
 - 10.1.9 PWM mode 178
 - 10.1.10 One-pulse mode 181
 - 10.1.11 Encoder interface mode 183
 - 10.1.12 Timer input XOR function 185



10.1.13	Timers and external trigger synchronization	186
10.1.14	Timer synchronization	190
10.1.15	Timer signal descriptions	196
10.2	Interrupts	197
10.3	General-purpose timers 1 and 2 registers	197
10.3.1	Timer x interrupt and status register (TIMx_ISR)	197
10.3.2	Timer x interrupt missed register (TIMx_MISSR)	198
10.3.3	Timer x interrupt enable register (TIMx_IER)	198
10.3.4	Timer x control register 1 (TIMx_CR1)	199
10.3.5	Timer x control register 2 (TIMx_CR2)	201
10.3.6	Timer x slave mode control register (TIMx_SMCR)	202
10.3.7	Timer x event generation register (TIMx_EGR)	205
10.3.8	Timer x capture/compare mode register 1 (TIMx_CCMR1)	206
10.3.9	Timer x capture/compare mode register 2 (TIMx_CCMR2)	210
10.3.10	Timer x capture/compare enable register (TIMx_CCER)	214
10.3.11	Timer x counter register (TIMx_CNT)	215
10.3.12	Timer x prescaler register (TIMx_PSC)	215
10.3.13	Timer x auto-reload register (TIMx_ARR)	216
10.3.14	Timer x capture/compare 1 register (TIMx_CCR1)	216
10.3.15	Timer x capture/compare 2 register (TIMx_CCR2)	217
10.3.16	Timer x capture/compare 3 register (TIMx_CCR3)	217
10.3.17	Timer x capture/compare 4 register (TIMx_CCR4)	218
10.3.18	Timer 1 option register (TIM1_OR)	218
10.3.19	Timer 2 option register (TIM2_OR)	219
10.3.20	General-purpose timers 1 and 2 (TIM1/TIM2) register map	220
11	Analog-to-digital converter	224
11.1	Functional description	225
11.1.1	Setup and configuration	225
11.1.2	GPIO usage	225
11.1.3	Voltage reference	225
11.1.4	Offset/gain correction	226
11.1.5	DMA	226
11.1.6	ADC configuration register	227
11.1.7	Operation	229
11.1.8	Calibration	230
11.2	Interrupts	232

11.3	Analog-to-digital converter (ADC) registers	233
11.3.1	ADC interrupt status register (ADC_ISR)	233
11.3.2	ADC interrupt enable register (ADC_IER)	233
11.3.3	ADC control register (ADC_CR)	234
11.3.4	ADC offset register (ADC_OFFSETR)	235
11.3.5	ADC gain register (ADC_GAINR)	235
11.3.6	ADC DMA control register (ADC_DMOCR)	236
11.3.7	ADC DMA status register (ADC_DMASR)	236
11.3.8	ADC DMA memory start address register (ADC_DMAMSAR)	237
11.3.9	ADC DMA number of data to transfer register (ADC_DMANDTR)	237
11.3.10	ADC DMA memory next address register (ADC_DMAMNAR)	238
11.3.11	ADC DMA count number of data transferred register (ADC_DMACNDTR)	238
11.3.12	Analog-to-digital converter (ADC) register map	239
12	Interrupts	241
12.1	Nested vectored interrupt controller (NVIC)	241
12.2	Management interrupt registers	243
12.2.1	Management interrupt source register (MGMT_ISR)	243
12.2.2	Management interrupt mask register (MGMT_IER)	244
12.2.3	Management interrupt (MGMT) register map	244
13	Debug support	245
13.1	STM32W108 JTAG TAP connection	246
14	Electrical characteristics	247
14.1	Parameter conditions	247
14.1.1	Minimum and maximum values	247
14.1.2	Typical values	247
14.1.3	Typical curves	247
14.1.4	Loading capacitor	247
14.1.5	Pin input voltage	247
14.2	Absolute maximum ratings	248
14.3	Operating conditions	249
14.3.1	General operating conditions	249
14.3.2	Operating conditions at power-up	249
14.3.3	Absolute maximum ratings (electrical sensitivity)	250

14.4	SPI interface characteristics	252
14.5	ADC characteristics	255
14.6	Clock frequencies	259
14.6.1	High frequency internal clock characteristics	259
14.6.2	High frequency external clock characteristics	259
14.6.3	Low frequency internal clock characteristics	260
14.6.4	Low frequency external clock characteristics	260
14.7	DC electrical characteristics	261
14.8	Digital I/O specifications	266
14.9	Non-RF system electrical characteristics	267
14.10	RF electrical characteristics	267
14.10.1	Receive	267
14.10.2	Transmit	268
14.10.3	Synthesizer	269
15	Package information	270
15.1	VFQFPN48 package information	270
15.2	VFQFPN40 package information	272
15.3	UFQFPN48 package information	276
16	Ordering information scheme	279
17	Revision history	281

List of tables

Table 1.	Description of abbreviations used for bit field access	18
Table 2.	Pin descriptions	20
Table 3.	STM32W108xx peripheral register boundary addresses	34
Table 4.	Flash memory	35
Table 5.	MEM register map and reset values	41
Table 6.	Generated resets	50
Table 7.	RST register map and reset values	52
Table 8.	System clock modes	56
Table 9.	CLK register map and reset values	63
Table 10.	MACTMR, WDG, and SLPTMR register map and reset values	73
Table 11.	PWR register map and reset values	87
Table 12.	1.8 V integrated voltage regulator specifications	90
Table 13.	GPIO configuration modes	94
Table 14.	Timer 2 output configuration controls	94
Table 15.	GPIO forced functions	95
Table 16.	IRQC/D GPIO selection	99
Table 17.	GPIO signal assignments	99
Table 18.	GPIO register map and reset values	108
Table 19.	SC1 GPIO usage and configuration	112
Table 20.	SC2 GPIO usage and configuration	112
Table 21.	SPI master GPIO usage	113
Table 22.	SPI master mode formats	114
Table 23.	SPI slave GPIO usage	116
Table 24.	SPI slave mode formats	117
Table 25.	I2C Master GPIO Usage	119
Table 26.	I2C clock rate programming	120
Table 27.	I2C master frame segments	121
Table 28.	UART GPIO usage	123
Table 29.	UART baud rate divisors for common baud rates	124
Table 30.	UART RTS/CTS flow control configurations	126
Table 31.	SC1/SC2 register map and reset values	155
Table 32.	Timer GPIO use	162
Table 33.	EXTRIGSEL clock signal selection	172
Table 34.	Counting direction versus encoder signals	184
Table 35.	Timer signal descriptions	196
Table 36.	TIM1/TIM2 register map and reset values	220
Table 37.	ADC GPIO pin usage	225
Table 38.	ADC inputs	227
Table 39.	Typical ADC input configurations	228
Table 40.	ADC sample times	229
Table 41.	ADC gain and offset correction equations	231
Table 42.	ADC register map and reset values	239
Table 43.	NVIC exception table	241
Table 44.	MGMT register map and reset values	244
Table 45.	Voltage characteristics	248
Table 46.	Current characteristics	248
Table 47.	Thermal characteristics	248
Table 48.	General operating conditions	249

Table 49.	POR HV thresholds	249
Table 50.	POR LVcore thresholds	249
Table 51.	POR LVmem thresholds	249
Table 52.	Reset filter specification for RSTB	250
Table 53.	ESD absolute maximum ratings	250
Table 54.	Electrical sensitivities	251
Table 55.	SPI characteristics	252
Table 56.	ADC module key parameters for 1 MHz sampling	255
Table 57.	ADC module key parameters for input buffer disabled and 6 MHz sampling	256
Table 58.	ADC module key parameters for input buffer enabled and 6MHz sampling	257
Table 59.	ADC characteristics	258
Table 60.	High-frequency RC oscillator characteristics	259
Table 61.	High-frequency crystal oscillator characteristics	259
Table 62.	Low-frequency RC oscillator characteristics	260
Table 63.	Low-frequency crystal oscillator characteristics	260
Table 64.	DC electrical characteristics	261
Table 65.	Digital I/O characteristics	266
Table 66.	Non-RF system electrical characteristics	267
Table 67.	Receive characteristics	267
Table 68.	Transmit characteristics	268
Table 69.	Synthesizer characteristics	269
Table 70.	VFQFPN48 - 48-pin, 7x7 mm, 0.5 mm pitch very thin profile fine pitch quad flat package mechanical data	271
Table 71.	VFQFPN40 - 40-pin, 6x6 mm, 0.5 mm pitch very thin profile fine pitch quad flat package mechanical data	273
Table 72.	UFQFPN48 - 48-lead, 7x7 mm, 0.5 mm pitch, ultra thin fine pitch quad flat package mechanical data	277
Table 73.	Document revision history	281

List of figures

Figure 1.	STM32W108xx block diagram	15
Figure 2.	48-pin VFQFPN pinout	19
Figure 3.	40-pin VFQFPN pinout	20
Figure 4.	STM32W108xB memory mapping	32
Figure 5.	STM32W108CC and STM32W108CZ memory mapping	33
Figure 6.	System module block diagram	46
Figure 7.	Clocks block diagram	54
Figure 8.	Power management state diagram	76
Figure 9.	GPIO block diagram	92
Figure 10.	Serial controller block diagram	111
Figure 11.	I2C segment transitions	122
Figure 12.	UART character frame format	125
Figure 13.	UART FIFOs	125
Figure 14.	RTS/CTS flow control connections	126
Figure 15.	General-purpose timer block diagram	161
Figure 16.	Counter timing diagram with prescaler division change from 1 to 4	163
Figure 17.	Counter timing diagram, internal clock divided by 1	164
Figure 18.	Counter timing diagram, internal clock divided by 4	165
Figure 19.	Counter timing diagram, update event when ARPE = 0 (TIMx_ARR not buffered)	165
Figure 20.	Counter timing diagram, update event when ARPE = 1 (TIMx_ARR buffered)	166
Figure 21.	Counter timing diagram, internal clock divided by 1	167
Figure 22.	Counter timing diagram, internal clock divided by 4	167
Figure 23.	Counter timing diagram, internal clock divided by 1, TIMx_ARR = 0x6	168
Figure 24.	Counter timing diagram, update event with ARPE = 1 (counter underflow)	169
Figure 25.	Counter timing diagram, update event with ARPE = 1 (counter overflow)	169
Figure 26.	Control circuit in Normal mode, internal clock divided by 1	170
Figure 27.	TI2 external clock connection example	171
Figure 28.	Control circuit in External Clock mode 1	171
Figure 29.	External trigger input block	172
Figure 30.	Control circuit in external clock mode 2	173
Figure 31.	Capture/compare channel (example: channel 1 input stage)	173
Figure 32.	Capture/compare channel 1 main circuit	174
Figure 33.	Output stage of capture/compare channel (channel 1)	174
Figure 34.	PWM input mode timing	176
Figure 35.	Output compare mode, toggle on OC1	178
Figure 36.	Edge-aligned PWM waveforms (ARR = 8)	179
Figure 37.	Center-aligned PWM waveforms (ARR = 8)	180
Figure 38.	Example of one pulse mode	182
Figure 39.	Example of counter operation in encoder interface mode	184
Figure 40.	Example of encoder interface mode with IC1FP1 polarity inverted	185
Figure 41.	Control circuit in Reset mode	186
Figure 42.	Control circuit in Gated mode	187
Figure 43.	Control circuit in Trigger mode	188
Figure 44.	Control circuit in External clock mode 2 + Trigger mode	189
Figure 45.	Master/slave timer example	190

Figure 46.	Gating Timer 2 with OC1REF of Timer 1	191
Figure 47.	Gating Timer 2 with enable of Timer 1	192
Figure 48.	Triggering timer 2 with update of Timer 1	193
Figure 49.	Triggering Timer 2 with enable of Timer 1	194
Figure 50.	Triggering Timers 1 and 2 with Timer 1 TI1 input	195
Figure 51.	ADC block diagram	224
Figure 52.	SWJ block diagram	245
Figure 53.	Pin loading conditions	247
Figure 54.	Pin input voltage	247
Figure 55.	SPI timing diagram - slave mode and CPHA = 0	253
Figure 56.	SPI timing diagram - slave mode and CPHA = 1 ⁽¹⁾	253
Figure 57.	SPI timing diagram - master mode ⁽¹⁾	254
Figure 58.	Transmit power consumption	264
Figure 59.	Transmit output power	265
Figure 60.	VFQFPN48 - 48-pin, 7x7 mm, 0.5 mm pitch very thin profile fine pitch quad flat package outline	270
Figure 61.	VFQFPN48 - 48-pin, 7x7 mm, 0.5 mm pitch very thin profile fine pitch quad flat package recommended footprint	271
Figure 62.	VFQFPN40 - 40-pin, 6x6 mm, 0.5 mm pitch very thin profile fine pitch quad flat package outline	272
Figure 63.	VFQFPN40 - 40-pin, 6x6 mm, 0.5 mm pitch very thin profile fine pitch quad flat package recommended footprint	274
Figure 64.	VFQFPN40 marking example (package top view)	275
Figure 65.	UFQFPN48 - 48-lead, 7x7 mm, 0.5 mm pitch, ultra thin fine pitch quad flat package outline	276
Figure 66.	UFQFPN48 - 48-lead, 7x7 mm, 0.5 mm pitch, ultra thin fine pitch quad flat package recommended footprint	277
Figure 67.	UFQFPN48 marking example (package top view)	278

1 Description

The STM32W108xx is a fully integrated system-on-chip that integrates a 2.4 GHz, IEEE 802.15.4-compliant transceiver, 32-bit ARM[®] Cortex[®]-M3 microprocessor, Flash and RAM memory, and peripherals of use to designers of 802.15.4-based systems.

The transceiver utilizes an efficient architecture that exceeds the dynamic range requirements imposed by the IEEE 802.15.4-2003 standard by over 15 dB. The integrated receive channel filtering allows for robust co-existence with other communication standards in the 2.4 GHz spectrum, such as IEEE 802.11 and Bluetooth. The integrated regulator, VCO, loop filter, and power amplifier keep the external component count low. An optional high performance radio mode (boost mode) is software-selectable to boost dynamic range.

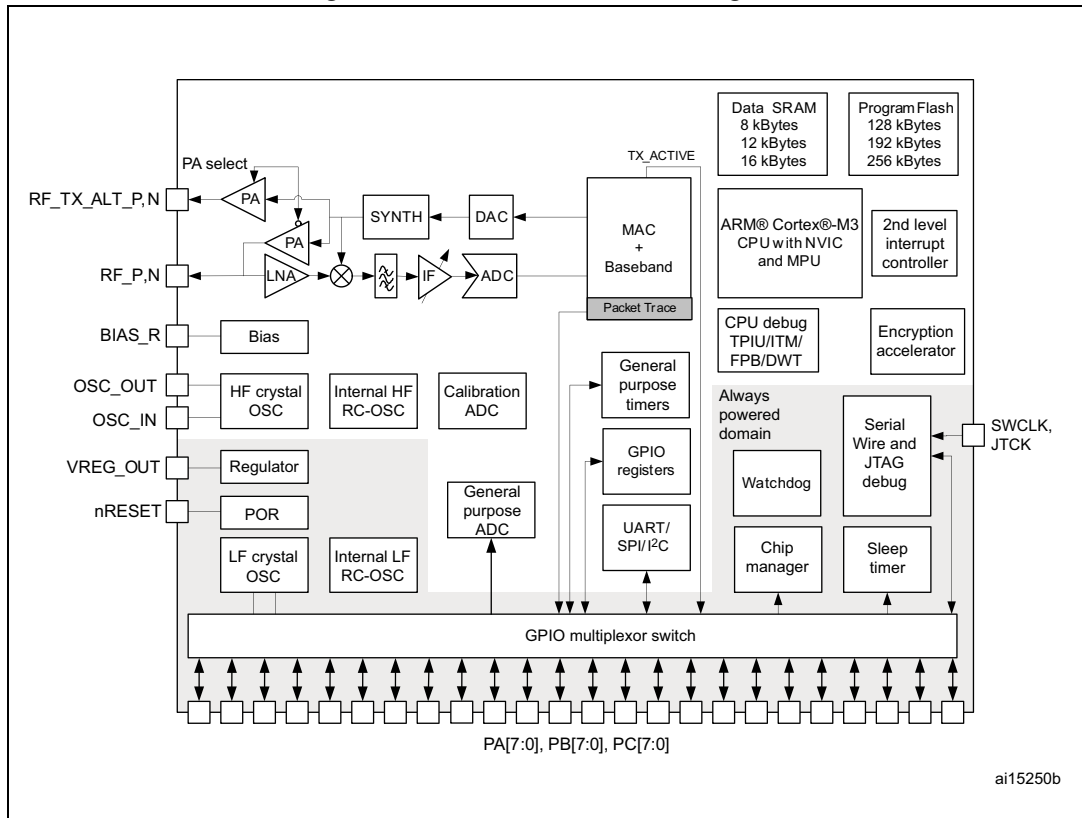
The integrated 32-bit ARM[®] Cortex[®]-M3 microprocessor is highly optimized for high performance, low power consumption, and efficient memory utilization. Including an integrated MPU, it supports two different modes of operation: Privileged mode and Unprivileged mode. This architecture could be used to separate the networking stack from the application code and prevent unwanted modification of restricted areas of memory and registers resulting in increased stability and reliability of deployed solutions.

The STM32W108xx has 128/192/256 Kbyte of embedded Flash memory and 8/12/16 Kbyte of integrated RAM for data and program storage. The STM32W108xx HAL software employs an effective wear-leveling algorithm that optimizes the lifetime of the embedded Flash.

To maintain the strict timing requirements imposed by the ZigBee and IEEE 802.15.4-2003 standards, the STM32W108xx integrates a number of MAC functions into the hardware. The MAC hardware handles automatic ACK transmission and reception, automatic backoff delay, and clear channel assessment for transmission, as well as automatic filtering of received packets. A packet trace interface is also integrated with the MAC, allowing complete, non-intrusive capture of all packets to and from the STM32W108xx.

The STM32W108xx offers a number of advanced power management features that enable long battery life. A high-frequency internal RC oscillator allows the processor core to begin code execution quickly upon waking. Various deep sleep modes are available with less than 1 μ A power consumption while retaining RAM contents. To support user-defined applications, on-chip peripherals include UART, SPI, I²C, ADC and general-purpose timers, as well as up to 24 GPIOs. Additionally, an integrated voltage regulator, power-on-reset circuit, and sleep timer are available.

Figure 1. STM32W108xx block diagram



1.1 Development tools

The STM32W108xx implements both the ARM Serial Wire and JTAG debug interfaces. These interfaces provide real time, non-intrusive programming and debugging capabilities. Serial Wire and JTAG provide the same functionality, but are mutually exclusive. The Serial Wire interface uses two pins; the JTAG interface uses five. Serial Wire is preferred, since it uses fewer pins.

The STM32W108xx also integrates the standard ARM system debug components: Flash Patch and Breakpoint (FPB), Data Watchpoint and Trace (DWT), and Instrumentation Trace Macrocell (DWT).

1.2 Overview

1.2.1 Functional description

The STM32W108xx radio receiver is a low-IF, super-heterodyne receiver. The architecture has been chosen to optimize co-existence with other devices in the 2.4 GHz band (namely, WIFI and Bluetooth), and to minimize power consumption. The receiver uses differential signal paths to reduce sensitivity to noise interference. Following RF amplification, the signal is downconverted by an image-rejecting mixer, filtered, and then digitized by an ADC.

The radio transmitter uses an efficient architecture in which the data stream directly modulates the VCO frequency. An integrated power amplifier (PA) provides the output power. Digital logic controls Tx path and output power calibration. If the STM32W108xx is to be used with an external PA, use the TX_ACTIVE or nTX_ACTIVE signal to control the timing of the external switching logic.

The integrated 4.8 GHz VCO and loop filter minimize off-chip circuitry. Only a 24 MHz crystal with its loading capacitors is required to establish the PLL local oscillator signal.

The MAC interfaces the on-chip RAM to the Rx and Tx baseband modules. The MAC provides hardware-based IEEE 802.15.4 packet-level filtering. It supplies an accurate symbol time base that minimizes the synchronization effort of the software stack and meets the protocol timing requirements. In addition, it provides timer and synchronization assistance for the IEEE 802.15.4 CSMA-CA algorithm.

The STM32W108xx integrates an ARM® Cortex®-M3 microprocessor, revision r1p1. This industry-leading core provides 32 bit performance and is very power efficient. It has excellent code density using the ARM® Thumb 2 instruction set. The processor can be operated at 12 MHz or 24 MHz when using the crystal oscillator, or at 6 MHz or 12 MHz when using the integrated high frequency RC oscillator.

The STM32W108xx has 128/192/256 Kbyte of Flash memory, 8/12/16 Kbyte of SRAM on-chip, and the ARM configurable memory protection unit (MPU).

The STM32W108xx contains 24 GPIO pins shared with other peripheral or alternate functions. Because of flexible routing within the STM32W108xx, external devices can use the alternate functions on a variety of different GPIOs. The integrated Serial Controller SC1 can be configured for SPI (master or slave), I²C (master-only), or UART operation, and the Serial Controller SC2 can be configured for SPI (master or slave) or I²C (master-only) operation.

The STM32W108xx has a general purpose ADC which can sample analog signals from six GPIO pins in single-ended or differential modes. It can also sample the regulated supply VDD_PADSA, the voltage reference VREF, and GND. The ADC has two selectable voltage ranges: 0 V to 1.2 V for the low voltage (input buffer disabled) and 0.1 V to VDD_PADS minus 0.1 V for the high voltage supply (input buffer enabled). The ADC has a DMA mode to capture samples and automatically transfer them into RAM. The integrated voltage reference for the ADC, VREF, can be made available to external circuitry. An external voltage reference can also be driven into the ADC.

The STM32W108xx contains four oscillators: a high frequency 24 MHz external crystal oscillator (24 MHz HSE OSC), a high frequency 12 MHz internal RC oscillator (12 MHz HSI RC), an optional low frequency 32.768 kHz external crystal oscillator (32 kHz HSE OSC), and a 10 kHz internal RC oscillator (10 kHz LSI RC).

The STM32W108xx has an ultra low power, deep sleep state with a choice of clocking modes. The sleep timer can be clocked with either the external 32.768 kHz crystal oscillator or with a 1 kHz clock derived from the internal 10 kHz LSI RC oscillator. Alternatively, all clocks can be disabled for the lowest power mode. In the lowest power mode, only external events on GPIO pins will wake up the chip. The STM32W108xx has a fast startup time (typically 100 μ s) from deep sleep to the execution of the first ARM[®] Cortex[®]-M3 instruction.

The STM32W108xx contains three power domains. The always-on high voltage supply powers the GPIO pads and critical chip functions. Regulated low voltage supplies power the rest of the chip. The low voltage supplies are be disabled during deep sleep to reduce power consumption. Integrated voltage regulators generate regulated 1.25 V and 1.8 V voltages from an unregulated supply voltage. The 1.8 V regulator output is decoupled and routed externally to supply analog blocks, RAM, and Flash memories. The 1.25 V regulator output is decoupled externally and supplies the core logic.

The digital section of the receiver uses a coherent demodulator to generate symbols for the hardware-based MAC. The digital receiver also contains the analog radio calibration routines and controls the gain within the receiver path.

In addition to 2 general-purpose timers, the STM32W108xx also contains a watchdog timer to ensure protection against software crashes and CPU lockup, a 32-bit sleep timer dedicated to system timing and waking from sleep at specific times and an ARM[®] standard system event timer in the NVIC.

The STM32W108xx integrates hardware support for a Packet Trace module, which allows robust packet-based debug.

Note: The STM32W108xx is not pin-compatible with the previous generation chip, the SN250, except for the RF section of the chip. Pins 1-11 and 45-48 are compatible, to ease migration to the STM32W108xx.

1.2.2 ARM[®] Cortex[®]-M3 core

The STM32W108xx integrates the ARM[®] Cortex[®]-M3 microprocessor, revision r1p1, developed by ARM Ltd, making the STM32W108xx a true system-on-a-chip solution. The ARM[®] Cortex[®]-M3 is an advanced 32-bit modified Harvard architecture processor that has separate internal program and data buses, but presents a unified program and data address space to software. The word width is 32 bits for both the program and data sides. The ARM[®] Cortex[®]-M3 allows unaligned word and half-word data accesses to support efficiently-packed data structures.

The ARM[®] Cortex[®]-M3 clock speed is configurable to 6 MHz, 12 MHz, or 24 MHz. For normal operation 12 MHz is preferred over 24 MHz due to its lower power consumption. The 6 MHz operation can only be used when radio operations are not required since the radio requires an accurate 12 MHz clock.

The ARM[®] Cortex[®]-M3 in the STM32W108xx has also been enhanced to support two separate memory protection levels. Basic protection is available without using the MPU, but the usual operation uses the MPU. The MPU protects unimplemented areas of the memory map to prevent common software bugs from interfering with software operation. The architecture could also separate the networking stack from the application code using a fine granularity RAM protection module. Errant writes are captured and details are reported to the developer to assist in tracking down and fixing issues.

2 Documentation conventions

Table 1. Description of abbreviations used for bit field access

Abbreviation	Description ⁽¹⁾
Read/Write (rw)	Software can read and write to these bits.
Read-only (r)	Software can only read these bits.
Write only (w)	Software can only write to this bit. Reading returns the reset value.
Read/Write in (MPU) Privileged mode only (rws)	Software can read and write to these bits only in Privileged mode. For more information, please refer to RAM memory protection on page 37 and Memory protection unit on page 42 .

1. The conditions under which the hardware (core) sets or clears this field are explained in details in the bit field description, as well as the events that may be generated by writing to the bit.

3 Pinout and pin description

Figure 2. 48-pin VFQFPN pinout

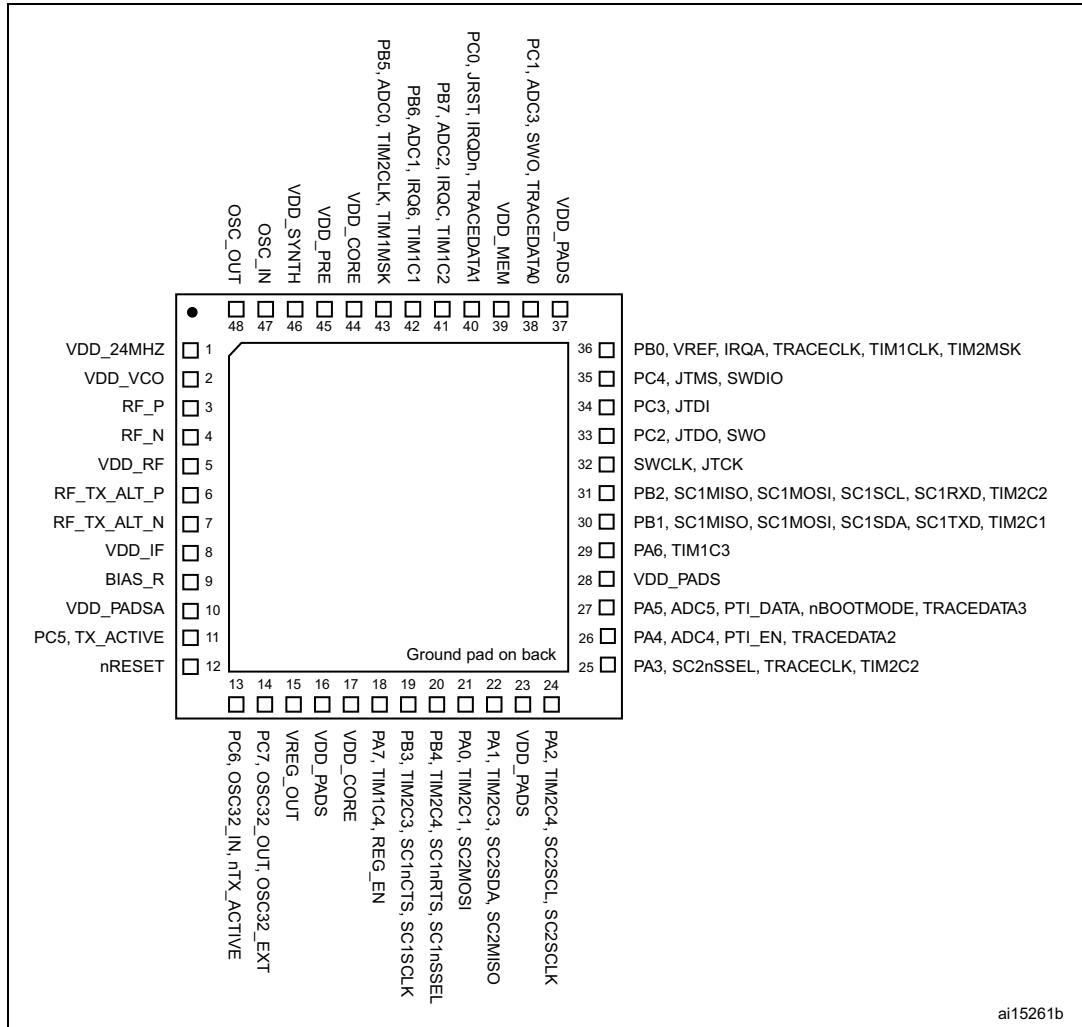


Figure 3. 40-pin VFQFPN pinout

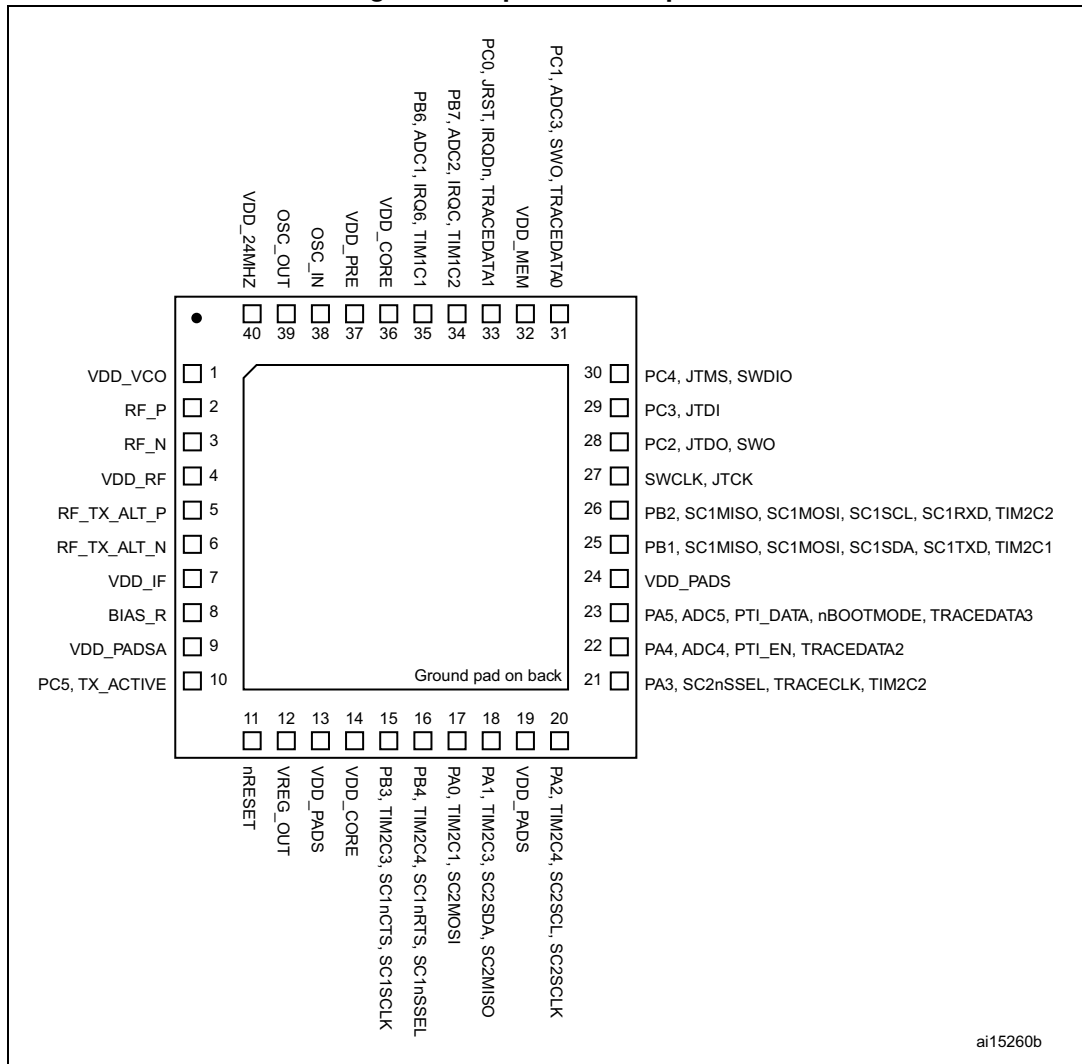


Table 2. Pin descriptions

48-Pin Package Pin no.	40-Pin Package Pin no.	Signal	Direction	Description
1	40	VDD_24MHZ	Power	1.8V high-frequency oscillator supply
2	1	VDD_VCO	Power	1.8V VCO supply
3	2	RF_P	I/O	Differential (with RF_N) receiver input/transmitter output
4	3	RF_N	I/O	Differential (with RF_P) receiver input/transmitter output
5	4	VDD_RF	Power	1.8V RF supply (LNA and PA)
6	5	RF_TX_ALT_P	O	Differential (with RF_TX_ALT_N) transmitter output (optional)
7	6	RF_TX_ALT_N	O	Differential (with RF_TX_ALT_P) transmitter output (optional)
8	7	VDD_IF	Power	1.8V IF supply (mixers and filters)
9	8	BIAS_R	I	Bias setting resistor

Table 2. Pin descriptions (continued)

48-Pin Package Pin no.	40-Pin Package Pin no.	Signal	Direction	Description
10	9	VDD_PADSA	Power	Analog pad supply (1.8V)
11	10	PC5	I/O	Digital I/O
		TX_ACTIVE	O	Logic-level control for external Rx/Tx switch. The STM32W108xx baseband controls TX_ACTIVE and drives it high (VDD_PADS) when in Tx mode. Select alternate output function with GPIOC_CRH[7:4]
12	11	nRESET	I	Active low chip reset (internal pull-up)
13		PC6	I/O	Digital I/O
		OSC32_IN	I/O	32.768 kHz crystal oscillator Select analog function with GPIOC_CRH[11:8]
		nTX_ACTIVE	O	Inverted TX_ACTIVE signal (see PC5) Select alternate output function with GPIOC_CRH[11:8]
14		PC7	I/O	Digital I/O
		OSC32_OUT	I/O	32.768 kHz crystal oscillator. Select analog function with GPIOC_CRH[15:12]
		OSC32_EXT	I	Digital 32 kHz clock input source
15	12	VREG_OUT	Power	Regulator output (1.8 V while awake, 0 V during deep sleep)
16	13	VDD_PADS	Power	Pads supply (2.1-3.6 V)
17	14	VDD_CORE	Power	1.25 V digital core supply decoupling
18		PA7	I/O High current	Digital I/O. Disable REG_EN with GPIO_DBGCR[4]
		TIM1_CH4	O	Timer 1 Channel 4 output Enable timer output with TIM1_CCER Select alternate output function with GPIOA_CRH[15:12] Disable REG_EN with GPIO_DBGCR[4]
			I	Timer 1 Channel 4 input. (Cannot be remapped.)
		REG_EN	O	External regulator open drain output. (Enabled after reset.)

Table 2. Pin descriptions (continued)

48-Pin Package Pin no.	40-Pin Package Pin no.	Signal	Direction	Description
19	15	PB3	I/O	Digital I/O
		TIM2_CH3 (see Pin 22)	O	Timer 2 channel 3 output Enable remap with TIM2_OR[6] Enable timer output in TIM2_CCER Select alternate output function with GPIOB_CRL[15:12]
			I	Timer 2 channel 3 input. Enable remap with TIM2_OR[6].
		UART_CTS	I	UART CTS handshake of Serial Controller 1 Enable with SC1_UARTCR[5] Select UART with SC1_CR
		SC1SCLK	O	SPI master clock of Serial Controller 1 Either disable timer output in TIM2_CCER or disable remap with TIM2_OR[6] Enable master with SC1_SPICR[4] Select SPI with SC1_CR Select alternate output function with GPIOB_CRL[15:12]
			I	SPI slave clock of Serial Controller 1 Enable slave with SC1_SPICR[4] Select SPI with SC1_CR
20	16	PB4	I/O	Digital I/O
		TIM2_CH4 (see also Pin 24)	O	Timer 2 channel 4 output Enable remap with TIM2_OR[7] Enable timer output in TIM2_CCER Select alternate output function with GPIOB_CRH[3:0]
			I	Timer 2 channel 4 input. Enable remap with TIM2_OR[7].
		UART_RTS	O	UART RTS handshake of Serial Controller 1 Either disable timer output in TIM2_CCER or disable remap with TIM2_OR[7] Enable with SC1_UARTCR[5] Select UART with SC1_CR Select alternate output function with GPIOB_CRH[3:0]
		SC1nSSEL	I	SPI slave select of Serial Controller 1 Enable slave with SC1_SPICR[4] Select SPI with SC1_CR

Table 2. Pin descriptions (continued)

48-Pin Package Pin no.	40-Pin Package Pin no.	Signal	Direction	Description
21	17	PA0	I/O	Digital I/O
		TIM2_CH1 (see also Pin 30)	O	Timer 2 channel 1 output Disable remap with TIM2_OR[4] Enable timer output in TIM2_CCER Select alternate output function with GPIOA_CRL[3:0]
			I	Timer 2 channel 1 input. Disable remap with TIM2_OR[4].
		SC2MOSI	O	SPI master data out of Serial Controller 2 Either disable timer output in TIM2_CCER or enable remap with TIM2_OR[4] Enable master with SC2_SPICR[4] Select SPI with SC2_CR Select alternate output function with GPIOA_CRL[3:0]
			I	SPI slave data in of Serial Controller 2 Enable slave with SC2_SPICR[4] Select SPI with SC2_CR
		22	18	PA1
TIM2_CH3 (see also Pin 19)	O			Timer 2 channel 3 output Disable remap with TIM2_OR[6] Enable timer output in TIM2_CCER Select alternate output function with GPIOA_CRL[7:4]
	I			Timer 2 channel 3 input. Disable remap with TIM2_OR[6].
SC2SDA	I/O			I ² C data of Serial Controller 2 Either disable timer output in TIM2_CCER or enable remap with TIM2_OR[6] Select I ² C with SC2_CR Select alternate open-drain output function with GPIOA_CRL[7:4]
SC2MISO	O			SPI slave data out of Serial Controller 2 Either disable timer output in TIM2_CCER or enable remap with TIM2_OR[6] Enable slave with SC2_SPICR[4] Select SPI with SC2_CR Select alternate output function with GPIOA_CRL[7:4]
	I			SPI master data in of Serial Controller 2 Enable slave with SC2_SPICR[4] Select SPI with SC2_CR
23	19	VDD_PADS	Power	Pads supply (2.1-3.6V)

Table 2. Pin descriptions (continued)

48-Pin Package Pin no.	40-Pin Package Pin no.	Signal	Direction	Description
24	20	PA2	I/O	Digital I/O
		TIM2_CH4 (see also Pin 20)	O	Timer 2 channel 4 output Disable remap with TIM2_OR[7] Enable timer output in TIM2_CCER Select alternate output function with GPIOA_CRL[11:8]
			I	Timer 2 channel 4 input. Disable remap with TIM2_OR[7].
		SC2SCL	I/O	I ² C clock of Serial Controller 2 Either disable timer output in TIM2_CCER or enable remap with TIM2_OR[7] Select I ² C with SC2_CR Select alternate open-drain output function with GPIOA_CRL[11:8]
		SC2SCLK	O	SPI master clock of Serial Controller 2 Either disable timer output in TIM2_CCER or enable remap with TIM2_OR[7] Enable master with SC2_SPICR[4] Select SPI with SC2_CR Select alternate output function with GPIOA_CRL[11:8]
			I	SPI slave clock of Serial Controller 2 Enable slave with SC2_SPICR[4] Select SPI with SC2_CR
25	21	PA3	I/O	Digital I/O
		SC2nSSEL	I	SPI slave select of Serial Controller 2 Enable slave with SC2_SPICR[4] Select SPI with SC2_CR
		TRACECLK (see also Pin 36)	O	Synchronous CPU trace clock Either disable timer output in TIM2_CCER or enable remap with TIM2_OR[5] Enable trace interface in ARM core Select alternate output function with GPIOA_CRL[15:12]
		TIM2_CH2 (see also Pin 31)	O	Timer 2 channel 2 output Disable remap with TIM2_OR[5] Enable timer output in TIM2_CCER Select alternate output function with GPIOA_CRL[15:12]
			I	Timer 2 channel 2 input. Disable remap with TIM2_OR[5].

Table 2. Pin descriptions (continued)

48-Pin Package Pin no.	40-Pin Package Pin no.	Signal	Direction	Description
26	22	PA4	I/O	Digital I/O
		ADC4	Analog	ADC Input 4. Select analog function with GPIOA_CRH[3:0].
		PTI_EN	O	Frame signal of Packet Trace Interface (PTI). Disable trace interface in ARM core. Select alternate output function with GPIOA_CRH[3:0].
		TRACEDATA2	O	Synchronous CPU trace data bit 2. Select 4-wire synchronous trace interface in ARM core. Enable trace interface in ARM core. Select alternate output function with GPIOA_CRH[3:0].
27	23	PA5	I/O	Digital I/O
		ADC5	Analog	ADC Input 5. Select analog function with GPIOA_CRH[7:4].
		PTI_DATA	O	Data signal of Packet Trace Interface (PTI). Disable trace interface in ARM core. Select alternate output function with GPIOA_CRH[7:4].
		nBOOTMODE	I	Embedded serial bootloader activation out of reset. Signal is active during and immediately after a reset on NRST. See Section 6.2: Resets on page 48 for details.
		TRACEDATA3	O	Synchronous CPU trace data bit 3. Select 4-wire synchronous trace interface in ARM core. Enable trace interface in ARM core. Select alternate output function with GPIOA_CRH[7:4]
28	24	VDD_PADS	Power	Pads supply (2.1-3.6 V)
29		PA6	I/O High current	Digital I/O
		TIM1_CH3	O	Timer 1 channel 3 output Enable timer output in TIM1_CCER Select alternate output function with GPIOA_CRH[11:8]
			I	Timer 1 channel 3 input (Cannot be remapped.)