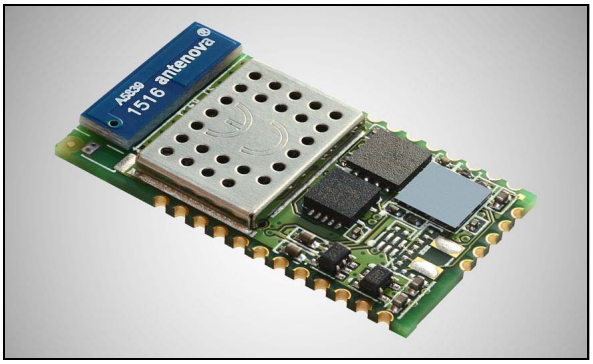
SPWF01SA
SPWF01SC

Serial-to-Wi-Fi b/g/n intelligent modules

Datasheet - production data



Features

- 2.4 GHz IEEE 802.11 b/g/n transceiver
- STM32 ARM Cortex-M3, with 64 KB RAM and 512 KB Flash memory
  - 1 MB extended Flash available on SPWF01Sx.1y
- Integrated TCP/IP protocol stack
  - 8 simultaneous TCP or UDP clients and 1 socket server
  - 1 TLS/SSL socket client supporting up to TLS 1.2, including common encryption algorithms: AES (128, 256), hash (MD5, SHA-1, SHA-256) and public key algorithms (RSA, ECC)
  - Web server supporting dynamic web pages
  - RESTful API to get and post web content
- WEP/WPA/WPA2 personal security
- System modes: Station, IBSS, and miniAP (supporting up to 5 stations)
- miniAP easily provisioned (SSID, PWD)
- Fast Wi-Fi reassociation after reset
- Firmware update via UART and Over The Air (FOTA); extended Flash on board with SPWF01Sx.1y
- TX power
  - 18.3 dBm @ 1 Mbps DSSS
  - 13.7 dBm @ 54 Mbps OFDM
- RX sensitivity
  - -96.0 dBm @ 1 Mbps DSSS
  - -74.5 dBm @ 54 Mbps OFDM
- 16 configurable GPIOs available
- UART interface to host system
- Advanced low-power modes
  - Standby with RTC: 43 µA
  - Sleep connected (DTIM=1): 15 mA
  - RX traffic: 105 mA typical
  - TX traffic: 243 mA typical @ 10 dBm
- Simple AT command set host interface through UART
- Small form factor: 26.92 x 15.24 x 2.35 mm
- Single voltage supply (3.3 V typical)
- Multiple antenna options:
  - Integrated antenna (SPWF01SA.xy versions)
  - Integrated u.fl connector (SPWF01SC.xy versions)
- Industrial temperature range: -40 °C to 85 °C
- FCC/CE/IC/SRRC certified
- RoHS compliant
- Surface mount PCB module

Applications

- Smart appliances
- Industrial control and data acquisition
- Home automation and security systems
- Wireless sensors
- Cable replacement
- Medical equipment
- Machine-to-machine communication

Contents

1 Description

The SPWF01SA and the SPWF01SC intelligent Wi-Fi modules represent a plug-and-play and standalone 802.11 b/g/n solution for easy integration of wireless Internet connectivity features into existing or new products.

Configured around a single-chip 802.11 transceiver with integrated PA and comprehensive power management subsystem, and an STM32 microcontroller with an extensive GPIO suite, the modules also incorporate timing clocks and voltage regulators. Two different options exist based on the integrated Flash memory. The SPWF01Sx.1y orderable parts integrate 1.5 MB of Flash, while the SPWF01Sx.2y orderable parts integrate 512 KB of Flash.

The module is available either configured with an embedded micro 2.45 GHz highly-efficient ISM band antenna (SPWF01SA), or with an u.fl connector for external antenna connection (SPWF01SC).

With low power consumption and ultra-compact (2.7 x 1.5 cm) footprint, the modules are ideal for fixed and mobile wireless applications, as well as challenging battery-operated applications.

The SPWF01Sx parts are released with an integrated full featured TCP/IP protocol stack with added web server and additional application service capabilities, such as REST API for accessing files on servers in the cloud and support for dynamic web pages with CGI/SSI functions to easily interact with the module and the host processor over the air.

For secure end-to-end communication with the cloud, an SSL/TLS stack is embedded in every module with no licensing charge. See application note AN4683 for details.

The SW package also includes an AT command layer interface for user-friendly access to the stack functionalities via the UART serial port. For details, see user manual UM1695.

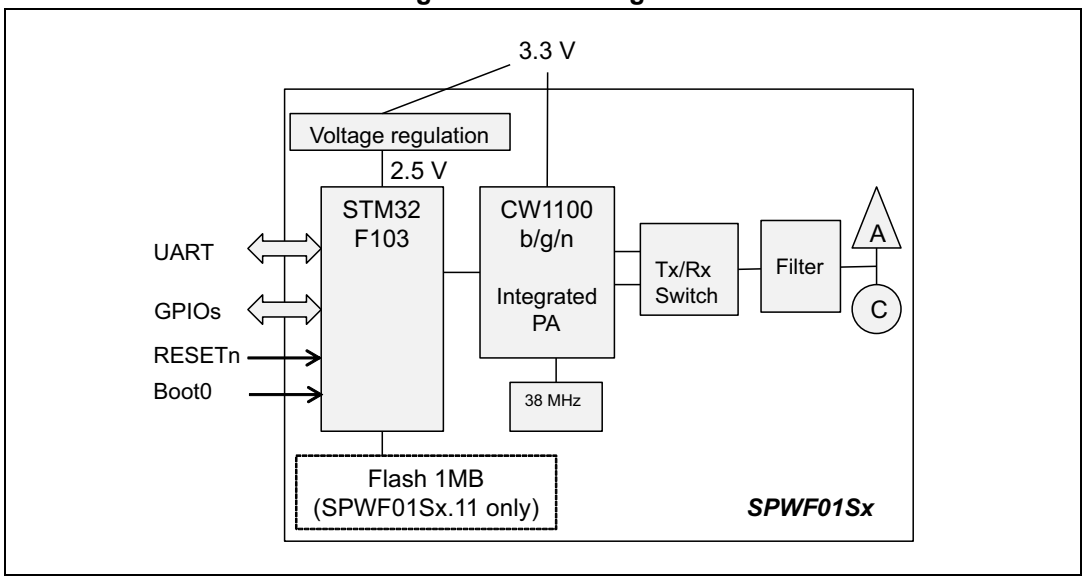
It is always possible to upgrade the module firmware via UART and Over The Air (FOTA).

Out of the 1 MB extended Flash available on the SPWF01Sx.1y module, 512 KB of the Flash is dedicated to FW upgrade and the other 512 KB is dedicated to host proprietary files, organized in a file system image, accessible through the integrated web server.

FOTA is also possible with the SPWF01Sx.2y module, temporarily storing the FW in the external host Flash memory, if it exists.

ST may update the FW provided with the modules at any time. ST recommends that users regularly check for documentation and the current FW version available at *www.st.com/wifimodules.*

Figure 1. Block diagram



2 General electrical specifications

Table 1. Absolute maximum ratings

Parameter	Test condition/comment	Min.	Typ.	Max.	Unit
Voltage supply	-	-0.3	-	4.0	V
Vin for 5 V tolerant pins		-0.3		5.5	V
Vin for all other pins		-0.3		2.8	V
Storage temperature range		-55		105	°C

Table 2. Operating conditions and input power specifications(1)

Parameter		Test condition/comment		Min.	Typ.	Max.	Unit
Operating temperature range		Industrial		-40		85	°C
3.3 V supply	Input supply voltage	3.3 V supply input		3.1	3.3	3.6	V
	Standby	Both the STM32 and the radio are in standby power states			43		µA
	Sleep	The STM32 is in stop power state and the radio is in sleep power state			15		mA
	Low power state	The STM32 is active and the radio is in sleep power state			26		mA
	TX	802.11b	TX power = 0 dBm		236		mA
			TX power = 10 dBm		250		mA
			TX power = 18 dBm		344		mA
		802.11g	TX power = 0 dBm		210		mA
			TX power = 10 dBm		243		mA
			TX power = 18 dBm		338		mA
	RX	802.11b			105		mA
		802.11g			105		mA

1. Typical results are at room temperature only.

3 Digital interface specifications

Table 3. Digital interface specifications, I/O pins

Parameter		Test condition/comment	Min.	Typ.	Max.	Unit
Inputs	VIH		1.6	-	2.8	V
	VIL				0.9	V
Outputs	VOH	IOH = 4 mA	2.1		2.5	V
	VOL	IOL = 4 mA			0.4	V

4 RF characteristics

Table 4. RF characteristics

Parameter		Test condition/comment	Min.	Typ.	Max.	Unit
	11b, 1 Mbps			-96		dBm
RX sensitivity(1)	11b, 2 Mbps			-93		dBm
	11b, 5.5 Mbps			-91		dBm
	11b, 11 Mbps			-87		dBm
	11g, 9 Mbps			-89.5		dBm
	11g, 18 Mbps			-86		dBm
	11g, 36 Mbps			-80		dBm
	11g, 54 Mbps			-74.5		dBm
	11n, MCS1, 13 Mbps			-86.5		dBm
	11n, MCS3, 26 Mbps			-81.5		dBm
	11n, MCS5, 52 Mbps			-74		dBm
	11n, MCS7, 65 Mbps			-71		dBm
Channel-to-channel de-sensitivity	CH1 to 14	11g, 54 Mbps, 10%PER		1		dB
Maximum input signal	CH7	11g, 54 Mbps		-20		dBm
Adjacent channel rejection	11Mbps			38		dBc
	9 Mbps			20		dBc
	54 Mbps			4		dBc
	MCS1			24		dBc
	MCS7			3		dBc
TX output power (1)	11b, 1 Mbps	@ 11b spectral mask		18.3		dBm
	11b, 11 Mbps			18.3		dBm
	11g, 9 Mbps	@ 11g spectral mask		18.3		dBm
	11g, 54 Mbps	EVM = -27 dB, 4.5%		13.7		dBm
	11n, MCS1	@ 11n spectral mask		18.3		dBm
	11n, MCS7	EVM = -27 dB		13.5		dBm
On-board antenna gain		Average		-1.2		dBi
External antenna gain		SG901-1066 average including cable loss		2.8		dBi

1. Output power and sensitivities are measured with a 50 Ω connection at the antenna port.

5 Pinout description

Table 5. Pinout description

Signal name	Type	Pin number	Main function	Alternate functions(1)	Notes
GPIO - general purpose input/output					
GPIO[0]	I/O	16	General purpose input/output Restore to factory settings(2)		Input pull down and 5V tolerant
GPIO[1]	I/O	17	General purpose input/output	PWM	Input pull down and 5V tolerant
GPIO[2]	I/O	19	General purpose input/output		Floating and 5V tolerant
GPIO[3]	I/O	1	General purpose input/output		Input pull down and 5V tolerant
GPIO[6]	I/O	22	General purpose input/output Wake Up/Sleep Inhibit(3)		Input pull down and 5V tolerant
GPIO[4]	I/O	18	General purpose input/output		
GPIO[5]	I/O	20	General purpose input/output		
GPIO[7]	I/O	13	General purpose input/output STA/Mini AP switch (4)		
GPIO[8]	I/O	4	General purpose input/output	ADC	
GPIO[9]	I/O	7	General purpose input/output		
GPIO[11]	I/O	11			
GPIO[12]	I/O	12	General purpose input/output		
GPIO[15]	I/O	21	General purpose input/output	DAC	
Monitoring purpose with no alternate function					
GPIO[10]	I/O	5	Drives LED, Blinks while running		
GPIO[13]	I/O	15	Drives LED, Wi-Fi link up		
GPIO[14]	I/O	14	LED drive, Power up		

Table 5. Pinout description (continued)

Signal name	Type	Pin number	Main function	Alternate functions(1)	Notes
UART pins					
RXD1	I	8	UART1 Receive data input		5V tolerant
TXD1	O	6	UART1 Transmit data output		5V Tolerant
CTS1_DN	I	9	UART1 Clear to send input		Active low, 5V tolerant
RTS1_DP	O	10	UART1 Request to send output		Active low, 5V tolerant
Reset					
RESETn	I	3	Reset input		Active low for 5 ms with pull up to 2.5VDC. Not 5V tolerant
Supply pins and paddle					
3.3 V		24	Voltage supply		Decouple with 10 µF capacitor
Ground		23	Ground		
Ground Paddle		25	Ground		Add plenty of ground vias for thermal dissipation and ground return
Boot loader					
BOOT0	I	2	Boot loader (5)		

1. The activation of ALT function depends upon the firmware version or upon the variable configuration.
2. To perform the factory reset of the variables, pin GPIO0 must be high during powerup.
3. GPIO function running when low power mode variable is enabled.
4. Introduced with the release 3.0 of AT Full stack. To enable the STAToMiniAP switch the GPIO[7] needs to be put low together with the HW reset.
5. To enable the firmware download, pin BOOT0 needs to be high during power up. RESETn need to be pulled low at least 5 ms to initiate the firmware download sequence.

Note: Pin 26 to Pin 30 are reserved and they can be left floating in the final design.

Application guidelines

As a general rule, when signals between the I/O pins of the external host processor and the module are to be connected (e.g. from 2.5 V to 3.3 V), a level translator should be used to match the voltage of the I/O pins.

Please refer to the data brief for the STEVAL-IDW001V1 evaluation board on st.com, which includes a schematic diagram illustrating the use of the level translator.

The HOST processor should control the RESETn pin of the module in order to recover from unexpected behavior using the HW reset.

6 Module reflow

The SPWF01SA and SPWF01SC are surface mount modules with a 6-layer PCB. The recommended final assembly reflow profiles are indicated below.

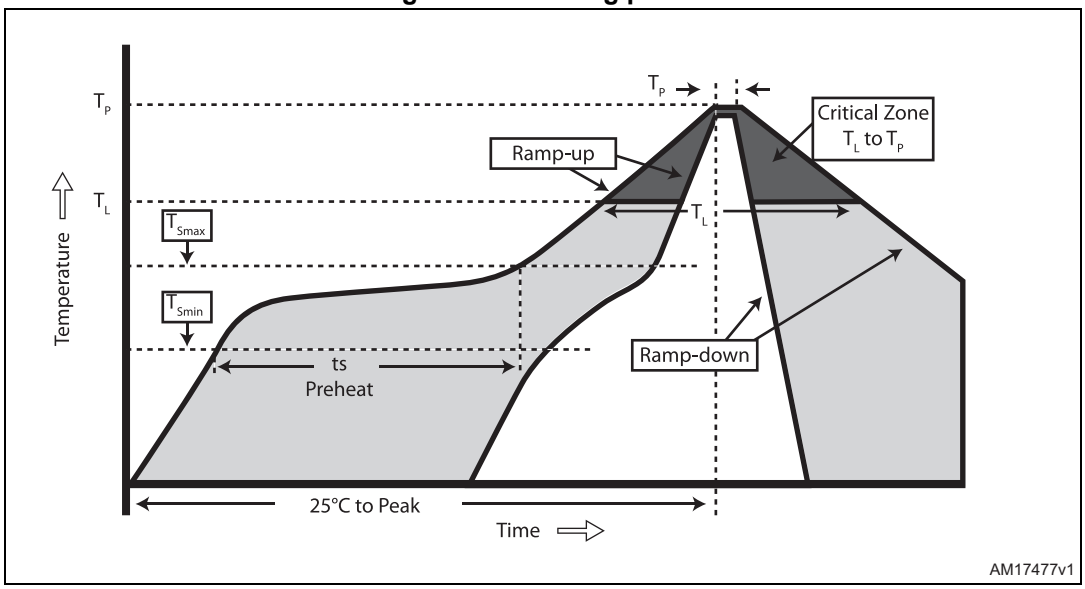
The soldering phase must be executed with care: in order to prevent an undesired melting phenomenon, particular attention must be paid to the setup of the peak temperature.

The following are some suggestions for the temperature profile based on the IPC/JEDEC J-STD-020C, July 2004 recommendations.

Table 6. Soldering values

Profile feature	PB-free assembly
Average ramp-up rate (T_{SMAX} to T_P)	3 °C/sec max
Preheat: – Temperature min. (T_s min.) – Temperature max. (T_s max.) – Time (T_s min. to T_s max) (ts)	 150 °C 200 °C 60-100 sec
Critical zone: Temperature T_L Time T_L	 217 °C 60-70 sec
Peak temperature (T_P)	240 + 0 °C
Time within 5 °C of actual peak temperature (T_P)	10-20 sec
Ramp-down rate	6 °C/sec
Time from 25 °C to peak temperature	8 minutes max.

Figure 2. Soldering profile



7 Regulatory compliance

7.1 RF compliance

The RF certifications obtained are described in *Table 7*.

Table 7. RF certification summary

		Comment
FCC ID	VRA-SG9011203	On board antenna and external SG901-1066 with connector version
IC ID	7420A-SG9011203	On board antenna and external SG901-1066 with connector version
ETSI	Compliant	Approved with on board antenna and connector version

Note: The SG901-1066 from Sagrad Inc. is the only approved antenna using the u.fl connector version.

7.2 FCC and IC

This module has been tested and complies with the FCC part 15 and IC RSS-210 regulations. These limits are designed to provide reasonable protection against harmful interference in approved installations. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation.

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions:

1. The device must not cause harmful interference.

and

2. The device must accept any interference received, including interference that may cause undesired operation.

Modifications or changes to this equipment not expressly approved by the party responsible for compliance may render void the user's authority to operate this equipment.

7.2.1 Modular approval, FCC and IC

FCC ID: VRA-SG9011203

IC: 7420A-SG9011203

In accordance with FCC part 15, the modules SPWF01SA and SPWF01SC are listed above as a modular transmitter device.

7.2.2 Labeling instructions

When integrating the SPWF01SA and SPWF01SC into the final product, it must be ensured that the FCC labeling requirements specified below are satisfied. Based on the Public Notice from FCC, the product into which the ST transmitter module is installed must display a label referring to the enclosed module. The label should use wording like the following:

Contains Transmitter Module

FCC ID: VRA-SG9011203

IC: 7420A-SG9011203

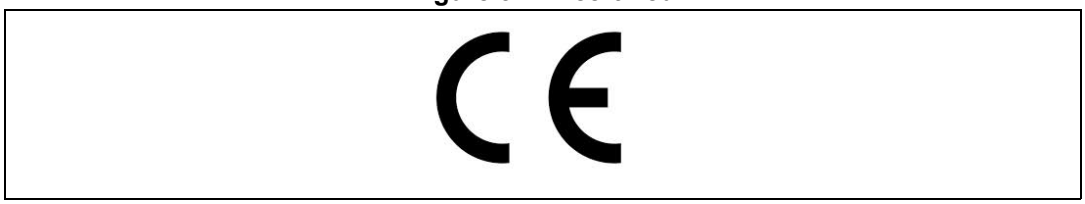
Any similar wording that expresses the same meaning may also be used.

7.3 CE

This module complies with the following European EMI/EMC and safety directives and standards:

- ETSI EN 300 238 v1.9.1:2015
- EN 301 489-1 V1.9.2:2011 + EN 301 489-17 V2.2.1:2009
- EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + A2:2013
- EN 62479:2010

Figure 3. CE certified



7.4 SRRC

The SPWF01Sx.21 module complies with Chinese SRRC certification.

- SRRC CMIIT ID: 2015DJ6514

8 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

8.1 Module shield package information

Figure 4. Top view of the module shield

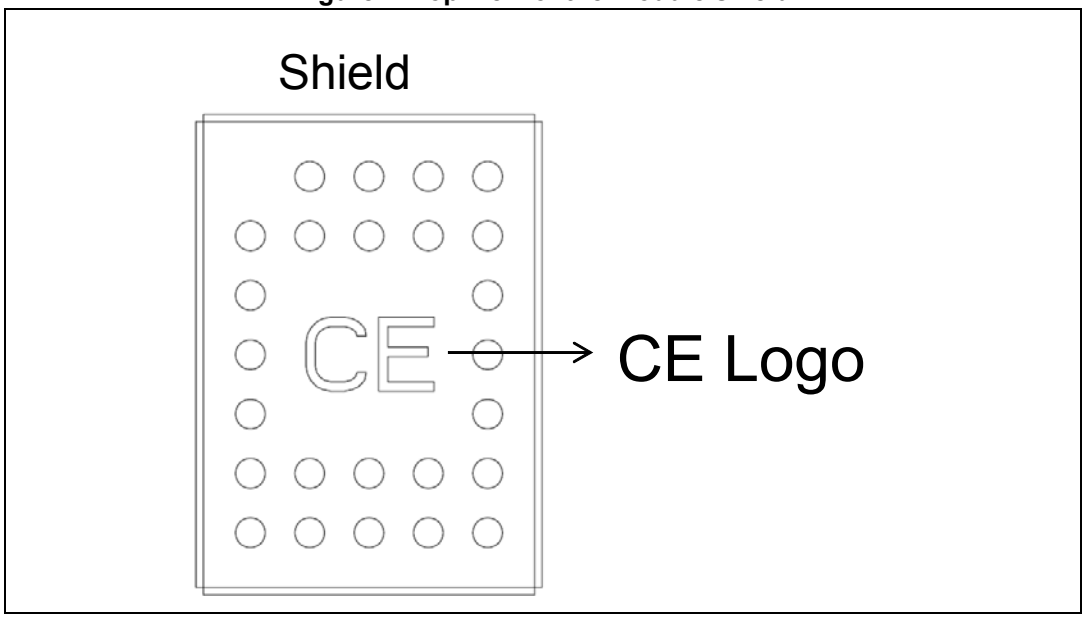


Figure 5. Bottom view of the module

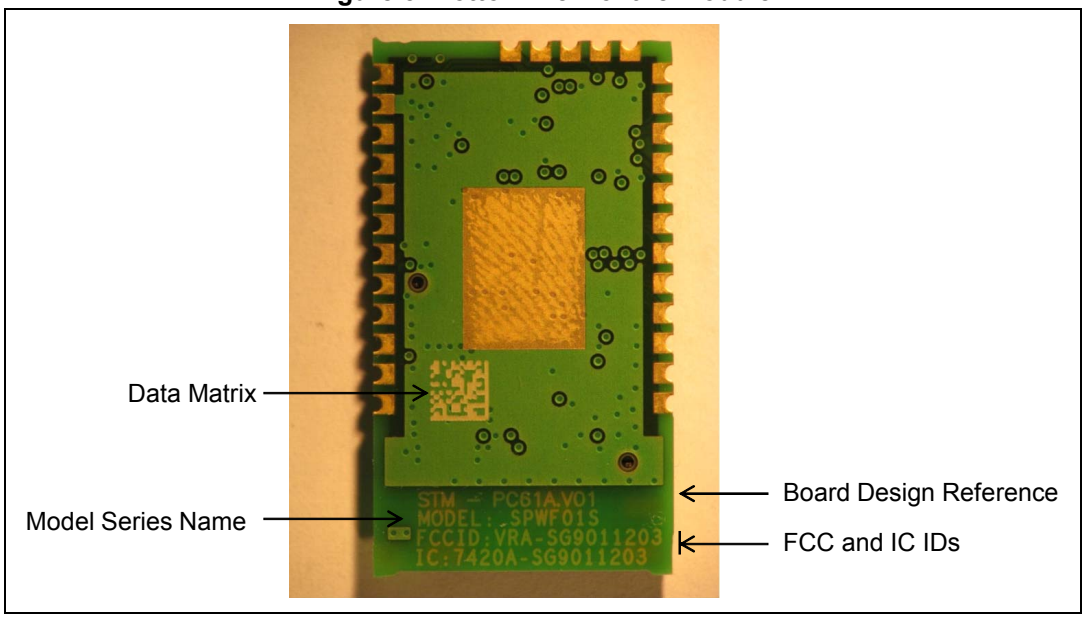
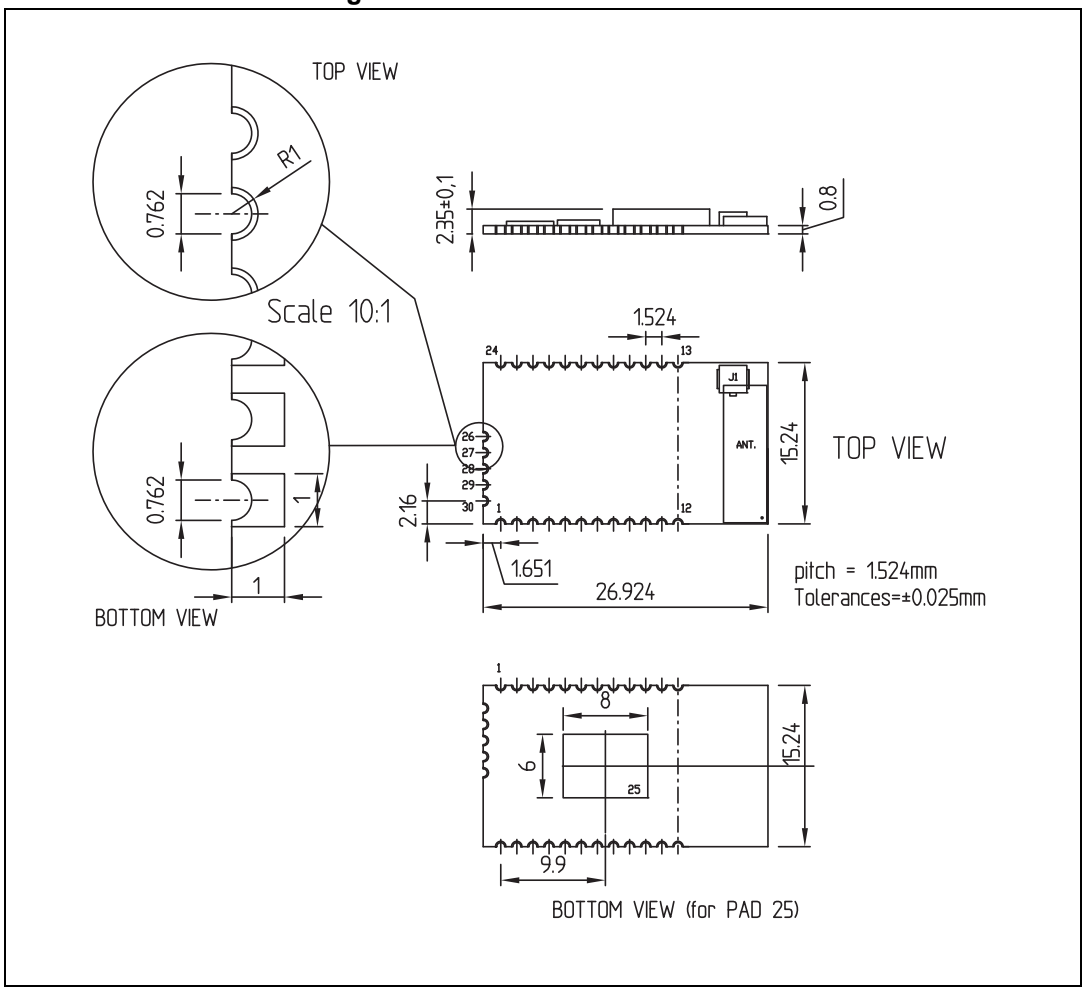
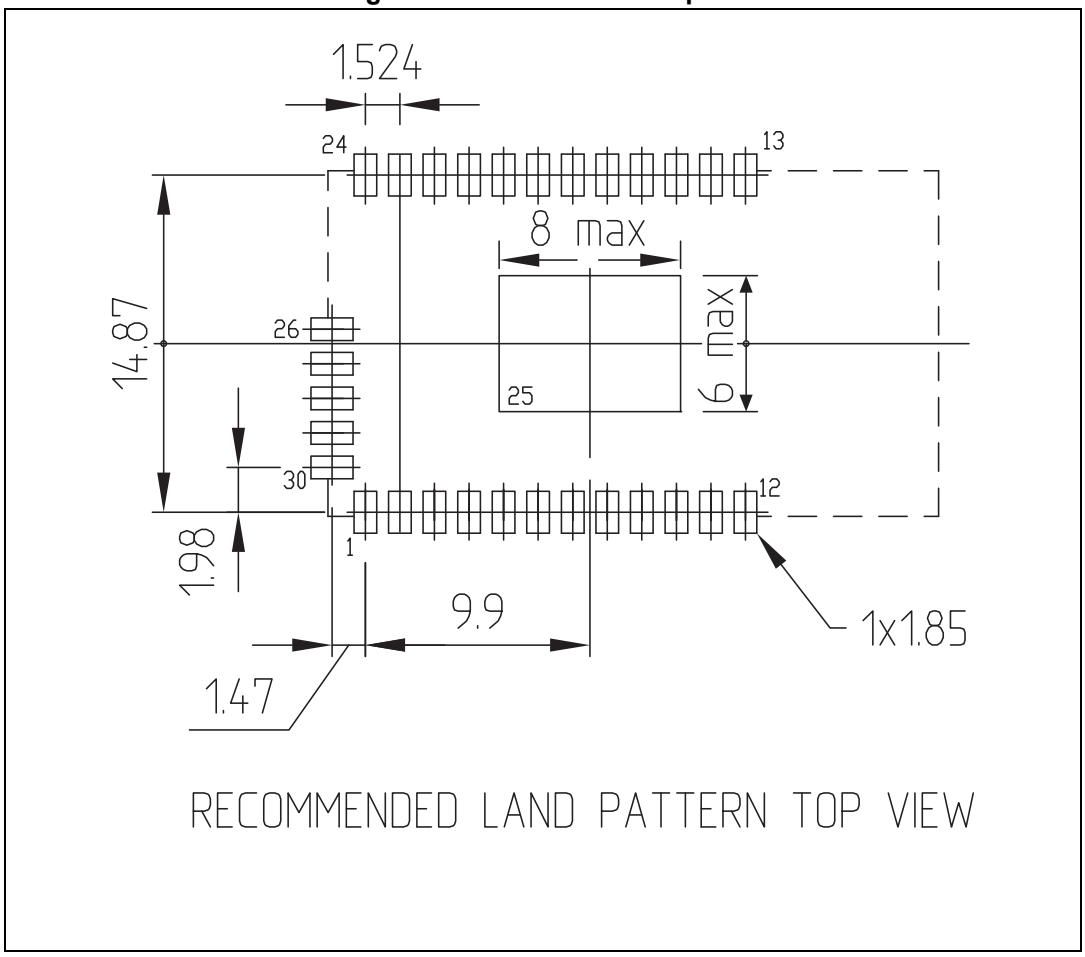


Figure 6. Wi-Fi module dimensions



Note: An antenna area of 217 x 520 mils must be free of any ground metalization or traces under the unit. The area extending away from the antenna should be free from metal on the PCB and housing to meet expected performance levels. Pin 25 is the required paddle ground and is not shown in this diagram.

Figure 7. Wi-Fi module footprint



PCB design requires a detailed review of the center exposed pad. This pad requires good thermal conductivity. Soldering coverage should be maximized and checked via x-ray for proper design. There is a trade-off between providing enough soldering for conductivity and applying too much, which allows the module to “float” on the paddle creating reliability issues. ST recommends two approaches, a large center via that allows excess solder to flow down into the host PCB with smaller vias around it, or many smaller vias with just enough space for the viscosity of the chosen solder/flux to allow some solder to flow into the smaller vias.

Either of these approaches must result in 60% or more full contact solder coverage on the paddle after reflow. ST strongly encourages PCB layout teams to work with their EMS providers to ensure vias and solder paste designs that will result in satisfactory performance.

9 Ordering information

Table 8. Ordering information

Order codes	Description
SPWF01SA.11	Wi-Fi module with integrated antenna, 1.5 MB of Flash and Wi-Fi full stack
SPWF01SC.11	Wi-Fi module with integrated u.fl connector, 1.5 MB of Flash and Wi-Fi full stack
SPWF01SA.21	Wi-Fi module with integrated antenna, 512 KB of Flash and Wi-Fi full stack
SPWF01SC.21	Wi-Fi module with integrated u.fl connector 512 KB of Flash and Wi-Fi full stack

Note: Refer to the user manual for a complete list of features and commands available in the Wi-Fi full stack.

10 Traceability information

Each module is univocally identified by the serial number stored in a 2D data matrix laser marked on the bottom side of the module itself.

The serial number has the following format:

Table 9. Traceability information letter meaning

Letter (s)	Meaning
WW	Week
YY	Year
D	Product ID family
FF	Production panel coordinate identification
NNN	Progressive serial number

Each module bulk is identified by a bulk ID.

BULK ID and module 2D data matrix are linked by a reciprocal traceability link.

The module 2D data matrix traces the lot number of any raw material used.

11 Revision history

Table 10. Document revision history

Date	Revision	Changes
05-Dec-2013	1	Initial release.
22-Jan-2014	2	*Figure 3* has been modified.
16-Apr-2014	3	Updated with references to modules with reduced Flash memory.
18-Sep-2014	4	Modified: *Figure 1* and *Table 3*
20-May-2015	5	Modified: *Features* and *Applications*
11-Nov-2015	6	Update picture in first page.
16-Mar-2016	7	– Added information regarding SRRC certification in *Features* and *Section 7: Regulatory compliance*. – Updated module photo on the coverpage and *Figure 1: Block diagram*. – Added information on upgrading the module firmware in the *Features* and *Description* sections. – Updated the text of *Application guidelines on page 9*. – Changed title of *Section 8* to Package information. – Updated image and caption of *Figure 6* and *Figure 7*. – Minor text changes throughout the document.
18-Jan-2017	8	– Updated *Section : Features on page 1* [added “(supporting up to 5 stations)”]. – Updated *Section 7.3: CE on page 14* (replaced “ETSI EN 300 328 V1.8.1:2012” by “ETSI EN 300 238 v1.9.1:2015”). – Added *Section 10: Traceability information on page 19*. – Minor modifications throughout document. – **Important note regarding a prior release of this datasheet:** The module photo on the coverpage was replaced, and modifications to *Figure 6* and *Figure 7* were implemented for revision 5, released on 20-May-2015. These changes were erroneously omitted from the change history for that revision. Please note that these changes were effective from revision 5, and have remained unchanged in all subsequent revisions up to the date of this revision.