AN4886
Application note

Wi-Fi module integration design guidelines

Introduction

SPWF01Sx modules are small-factor 802.11 b/g/n Wi-Fi modules with on-board radio and microcontroller running a complete set of TCP/IP protocols and applications. They are designed for embedded applications where high priority is placed on system cost, time-to-market, power consumption and ease of use.

This application note is intended for hardware and system designers that integrate an SPWF01Sx module into a custom design. It describes best practices for SPWF01Sx hardware integration into their target application.

Contents

1 Covered Wi-Fi module variants 3
2 SPWF01S power supply 4
3 SPWF01S reset signal behavior 6
4 PCB layout recommendations 9
4.1 PCB pad layout 9
4.2 PCB stack up 9
4.3 Power supply 9
4.4 Ground plane 9
4.5 SPWF01SA module placement 9
4.6 SPWF01SA placement strategy 10
4.7 Layout of other components around the SPWF01SA 11
4.8 SPWF01SC module placement 12
4.9 External antenna recommendations 13
5 References 14
6 Revision history 15

1 Covered Wi-Fi module variants

The guidelines described in this application note can be applied to the versions summarized in *Table 1: "SPWF01S variants"* which indicate the commercial part numbers of the complete set of ST Wi-Fi modules.

The part number prefix, SPWF01S, will be used hereafter unless an indication relates to a specific version, in which case the part number used will be SPWF01SA for modules with integrated antenna, and SPWF01SC for modules with integrated U.FL. connector.

Table 1: SPWF01S variants

Part number	Description
SPWF01SA.11	Wi-Fi module with integrated antenna and 1.5 MB of embedded Flash
SPWF01SA.21	Wi-Fi module with integrated antenna and 0.5 MB of embedded Flash
SPWF01SC.11	Wi-Fi module with integrated U.FL connector and 1.5 MB of embedded Flash
SPWF01SC.21	Wi-Fi modue with integrated U.FL connector and 0.5 MB of embedded Flash

2 SPWF01S power supply

The SPWF01S modules support multiple power modes: standby, sleep, low power, and active. For each power mode, *Table 2: "Operating conditions and input power specifications"* summarizes the status of the microprocessor and radio integrated in the module, and the related typical consumption values.

Table 2: Operating conditions and input power specifications

Parameter		Test condition/comment		Min.	Typ.(1)	Max	Unit
Operating temperature range		Industrial		-40		85	°C
3.3V supply	Input supply voltage	3.3 V supply input		3.1	3.3	3.6	V
	Standby	Corresponds to both the micro and the radio in standby power states			43		µA
	Sleep	Corresponds to the micro in stop power state and the radio in sleep power state			15		mA
	Low power(2)	Corresponds to the micro active and the radio in sleep power state			26		
	TX Active state(3)	802.11b	TX power=0 dBm		236		
			TX power=10 dBm		250		
			TX power=18 dBm		344		
		802.11g	TX power=0 dBm		210		
			TX power=10 dBm		243		
			TX power=18 dBm		338		
	RX Active state(2)	802.11b			105		
		802.11g			105		

Notes:

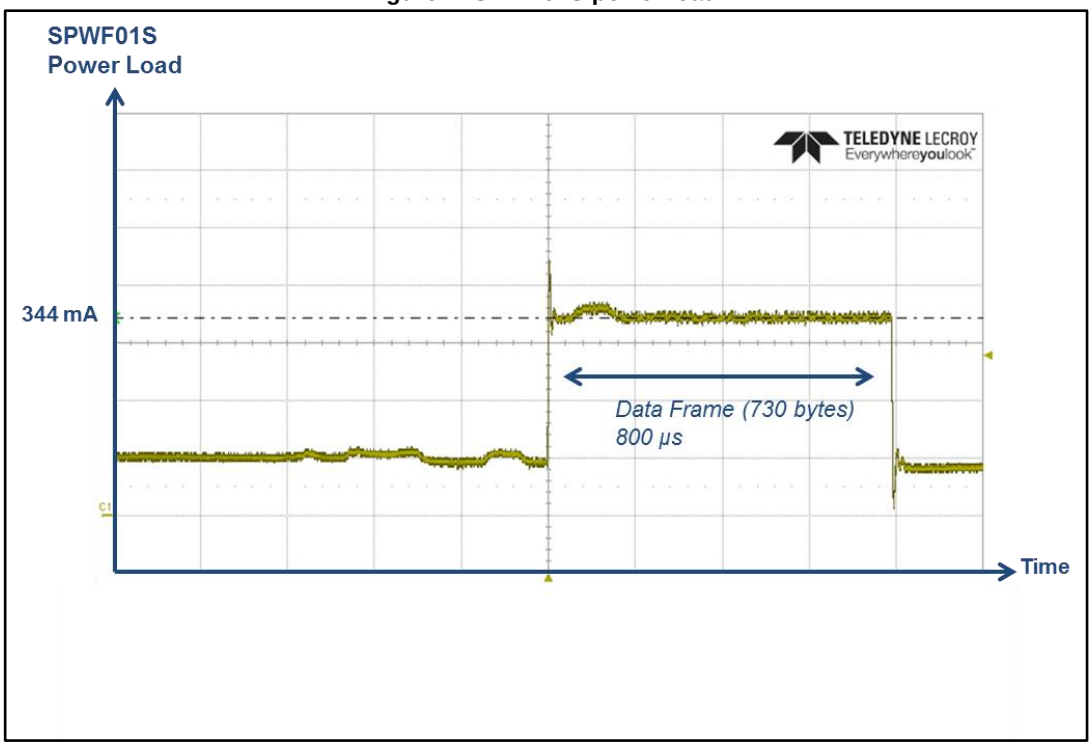
(1)Typical results are at room temperature only

(2)Module variables: wifi_mode=1 (STA mode), wifi_channelnum=6 (set by the AP), sleep_enabled=0, wifi_powersave=1, wifi_operational_mode=11, wifi_beacon_wakeup=1, wifi_listen_interval=0

(3)Module variables: wifi_mode=1 (STA mode), wifi_channelnum=6 (set by the AP).
Traffic model:
-TX: continuous streaming from module to target end device using secure socket (ECC521 mutual, chunk=4 KB)
-RX: continuous streaming from end device to module (RX)

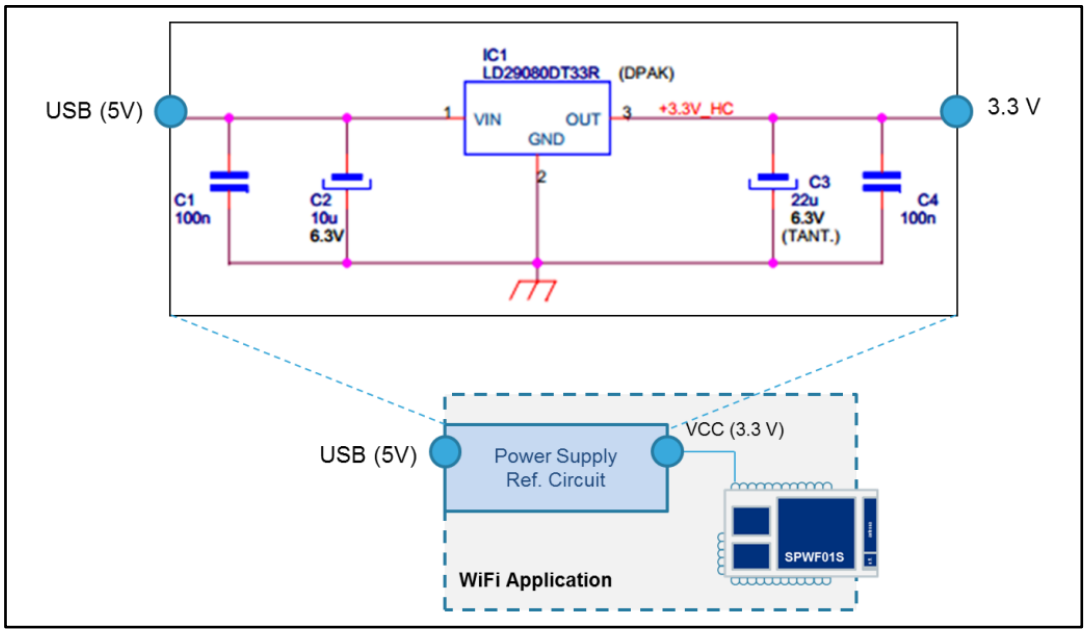
The screen capture in *Figure 1: "SPWF01S power load"* shows the typical power load when a typical data frame is sent using 802.11b mode at the maximum power output of 18 dBm.

Figure 1: SPWF01S power load



It is recommended that users of the module design an appropriate power supply circuit for their application. The recommended supply current for the module is in the range of 800 mA. In *Figure 2: "Power supply reference circuit"*, a reference design is provided based on ST's LD29080DT33R voltage regulator chipset, which guarantees the recommended supply conditions.

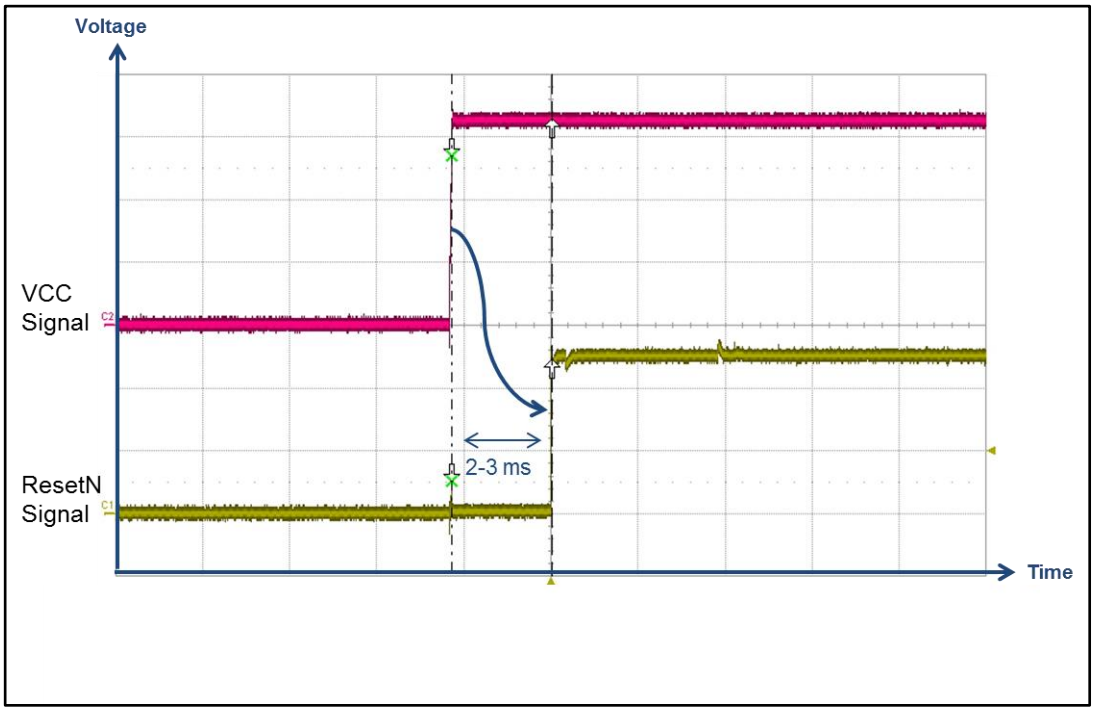
Figure 2: Power supply reference circuit



3 SPWF01S reset signal behavior

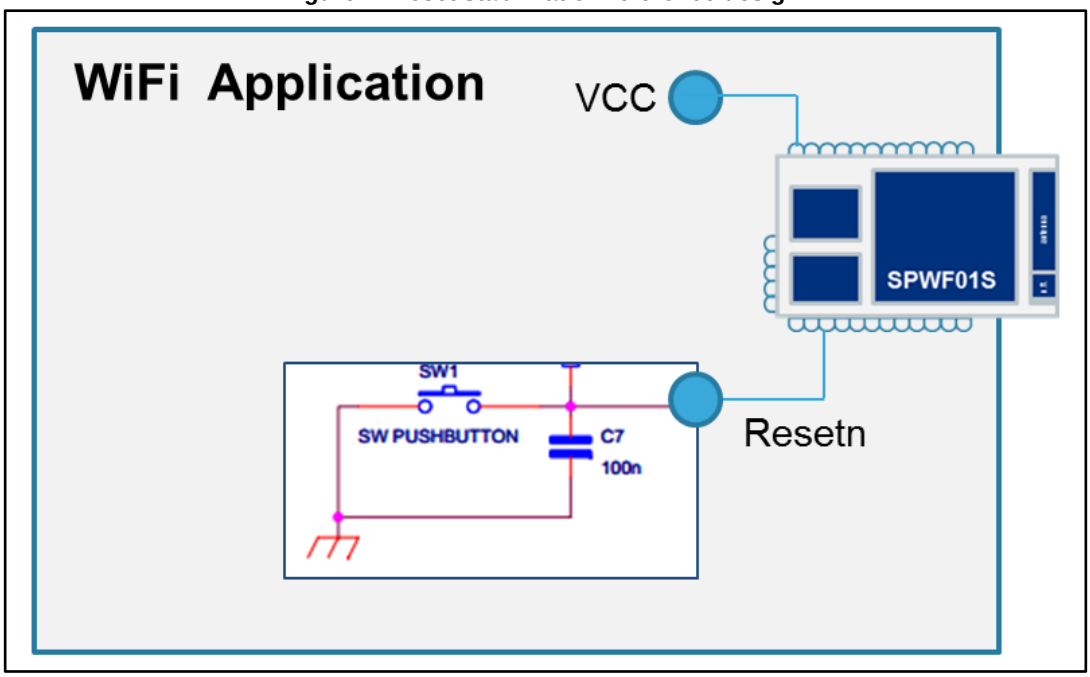
As shown in *Figure 3: "Reset stabilization cycle"*, at power-up the reset signal requires a time interval in the range of 2-3 ms to stabilize at the high voltage value (off condition).

Figure 3: Reset stabilization cycle



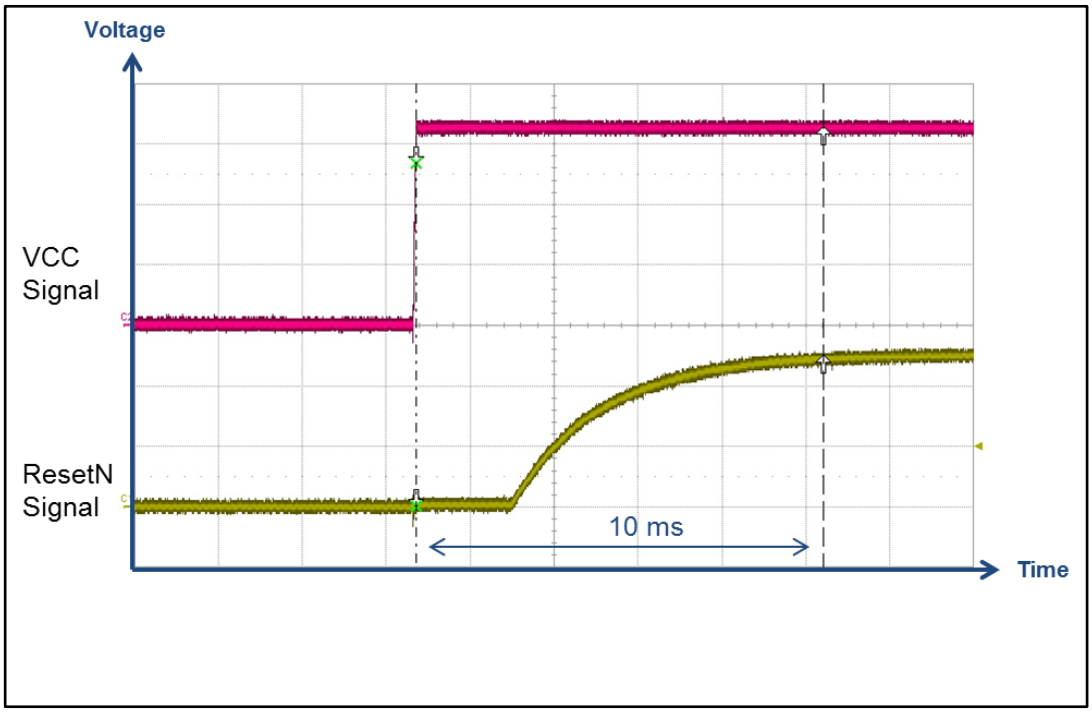
In order to make the reset stabilization time deterministic, the use of a 100 nF capacitor is recommended, as indicated in the reference circuit of *Figure 4: "Reset stabilization reference design"*.

Figure 4: Reset stabilization reference design



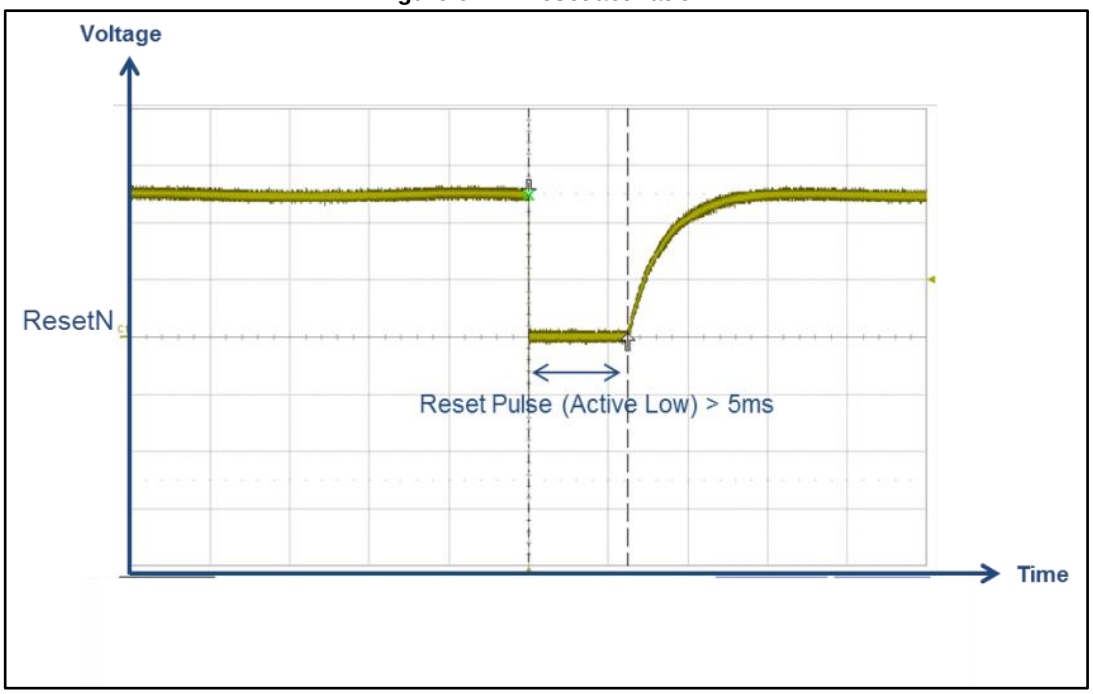
The correspondent reset stabilization cycle is indicated in *Figure 5: "Reset stabilization cycle"*.

Figure 5: Reset stabilization cycle



As specified in the module datasheet [*1*], in order to generate a hardware reset signal, the reset pin needs to be pulled down for a minimum interval of 5 ms, as represented in *Figure 6: "HW reset activation"*.

Figure 6: HW reset activation



4 PCB layout recommendations

4.1 PCB pad layout

The recommended pad footprint layout and solder mask of the SPWF01S modules are indicated in the datasheet [*1*].

4.2 PCB stack up

The SPWF01S modules do not set specific requirements for the PCB stack up of the application in which they are integrated. A simple 2-layer PCB stack up may be used to keep the costs low.

4.3 Power supply

It is recommended to keep the power supply line for VCC as short and low-impedance as possible.

4.4 Ground plane

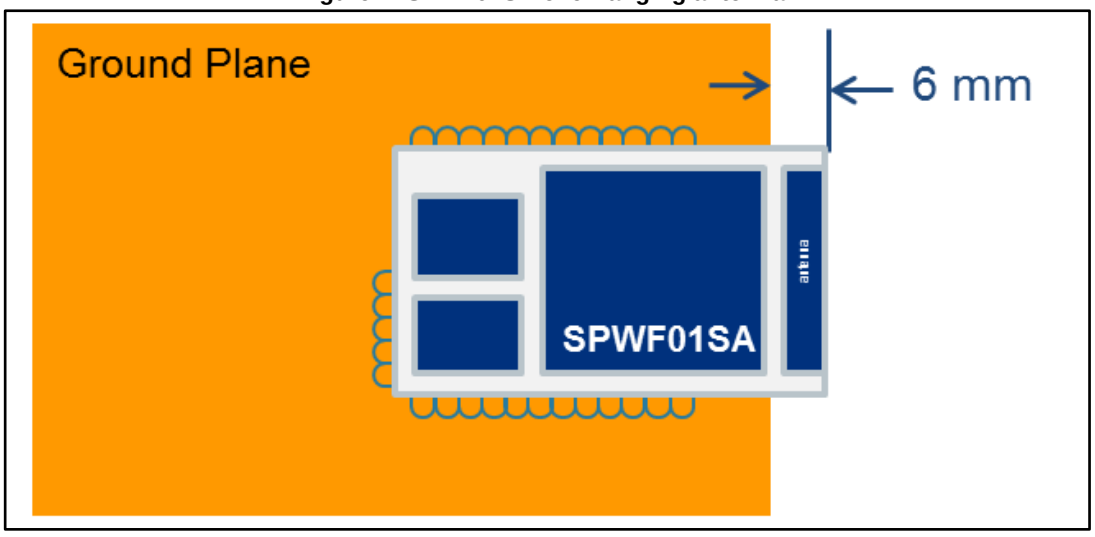
It is recommended to use a copper ground plane under the SPWF01S modules. The ground plane should be unbroken in the module's bottom internal pin connections area.

4.5 SPWF01SA module placement

The antenna radiation pattern of the SPWF01SA is influenced by the ground planes of the PCB holding the module.

It is recommended to place the Wi-Fi module antenna outside the PCB edge as represented in *Figure 7: "SPWF01SA overhanging antenna"*. It is important that the module GND pins have a good connection to the PCB ground plane, therefore it is recommended to place GND vias close to all module GND pins.

Figure 7: SPWF01SA overhanging antenna



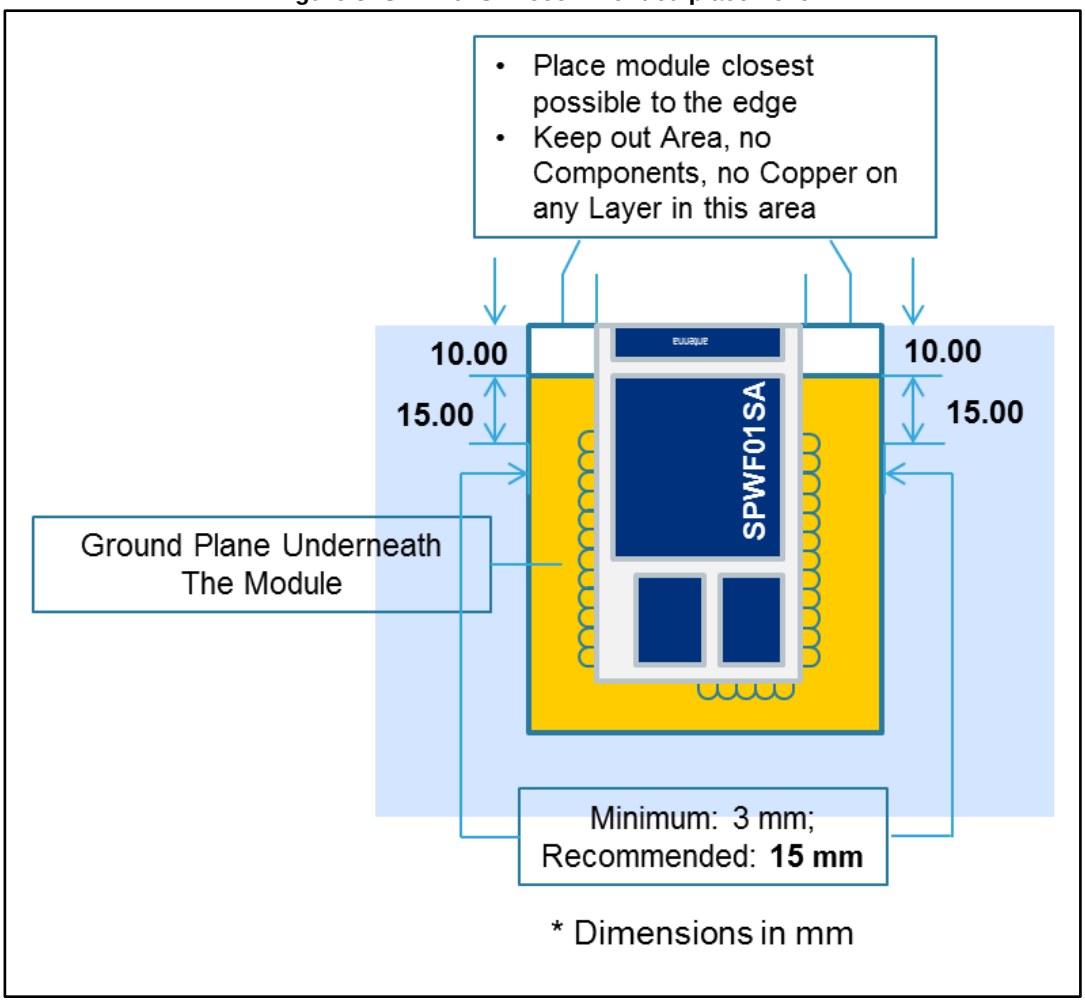
4.6 SPWF01SA placement strategy

The SPWF01SA modules are RF devices that require proper placement on the PCB to ensure optimal performance. The antenna on the PCB has an omnidirectional radiation pattern. To maximize antenna efficiency, an adequate grounding plane must be provided under the module. However, the areas underneath and surrounding the antenna area must be free of copper. The position of the module on the host board and overall design of the product enclosure contribute to antenna performance. Poor design affects radiation patterns and can result in reflection, diffraction, and/or scattering of the transmitted signal, thus limiting the range.

Basic guidelines:

- Never place the ground plane or route copper traces directly underneath the antenna portion of the module
- Never place the antenna close to metallic objects
- Keep wiring, components and objects away from antenna
- Do not place the antenna in a metallic or metalized plastic enclosure
- Enclosure walls should be 1 cm or more away from the antenna in all directions
- If possible, mount the antenna overhanging the edge of the host board. Add an uninterrupted ground plane on the host board, directly underneath the module, up to the PCB edge. Adding a ground plane will allow traces to be run on the bottom side of the host board if required
- If the antenna cannot be mounted in an overhanging position, then provisions must be made to keep the area clear of copper, as recommended in the diagram
- For designs that require an external antenna and U.FL connector, use the recommended antenna. The rules for on-edge placement are not required
- A ground plane is necessary underneath the module

Figure 8: SPWF01SA recommended placement

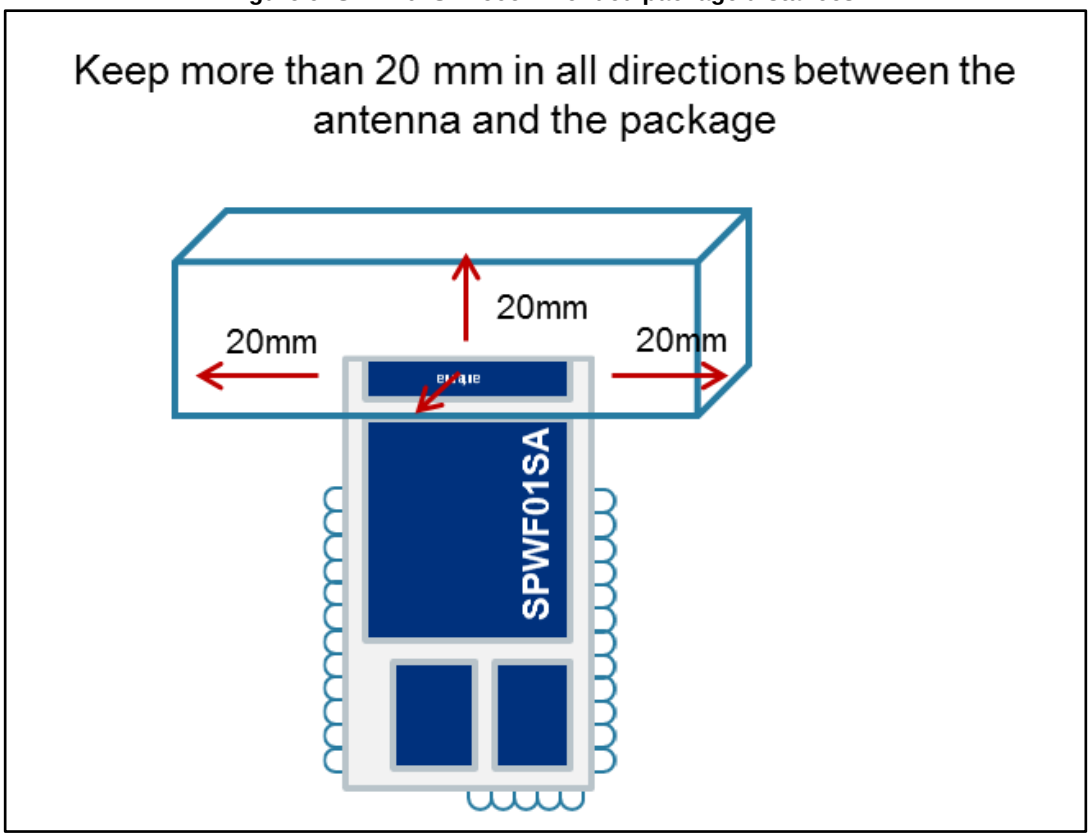


4.7 Layout of other components around the SPWF01SA

If any components containing metal conductors or conductive substances are placed close to the antenna, it could obstruct radio wave radiation, which can lead to significantly reduced communication distance.

Keep the antenna away from metal conductors, in accordance with the indications in *Figure 9*.

Figure 9: SPWF01SA recommended package distances

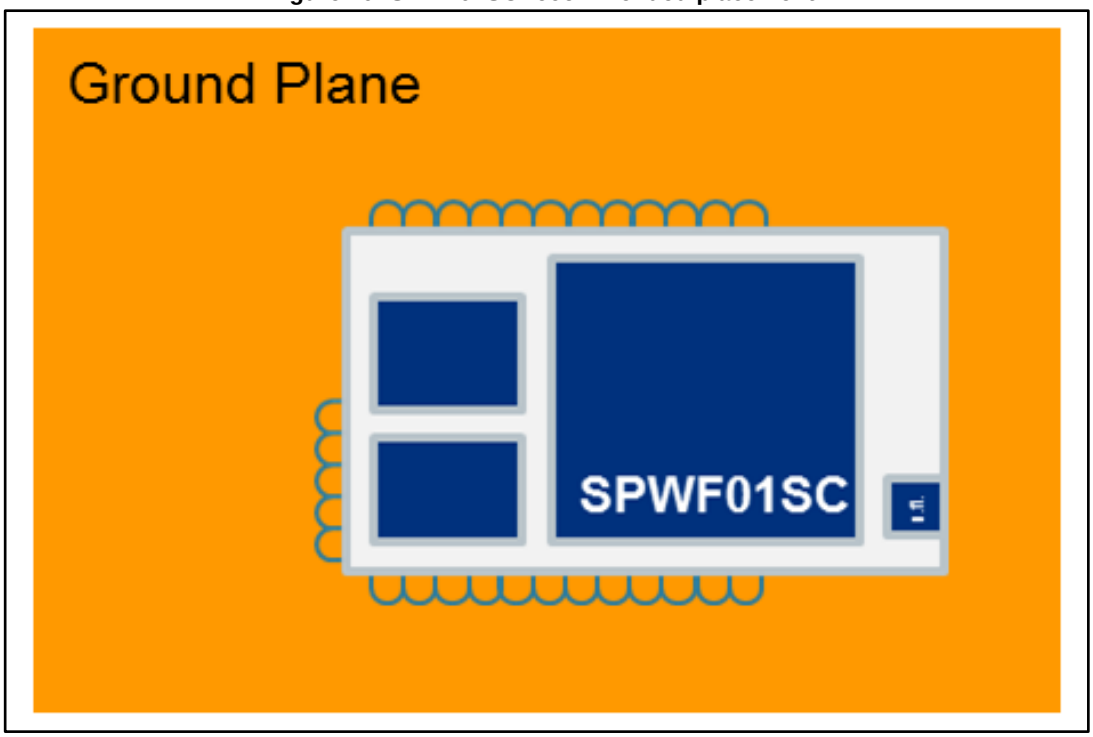


4.8 SPWF01SC module placement

When an external antenna is preferred in the target application, the SPWF01SC module with integrated U.FL. connector can be used.

Figure 10: "SPWF01SC recommended placement" shows the recommended placement of the Wi-Fi - EX module.

Figure 10: SPWF01SC recommended placement



4.9 External antenna recommendations

We recommend the certified “SAGRAD SG901-1066 ANTENNA” for modules that require an external antenna. This antenna has been qualified and approved for use by regulatory agencies in the US, Canada and European Union under the Modular Approval certification, [*1*].

The use of any antenna that does not meet the same parameters as the recommended antenna voids the Modular Approval grant.

Please follow the recommended rules for optimal performance:

- Place the antenna vertically to obtain the longest range and best communication
- Allow 75-130 mm of clearance from the antenna to any metallic objects

5 References

1. DS10078 Serial-to-Wi-Fi b/g/n intelligent modules
2. UM1695 Command set reference guide for "AT full stack" for SPWF01Sx series of Wi-Fi modules

6 Revision history

Table 3: Document revision history

Date	Version	Changes
07-Oct-2016	1	Initial release.

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