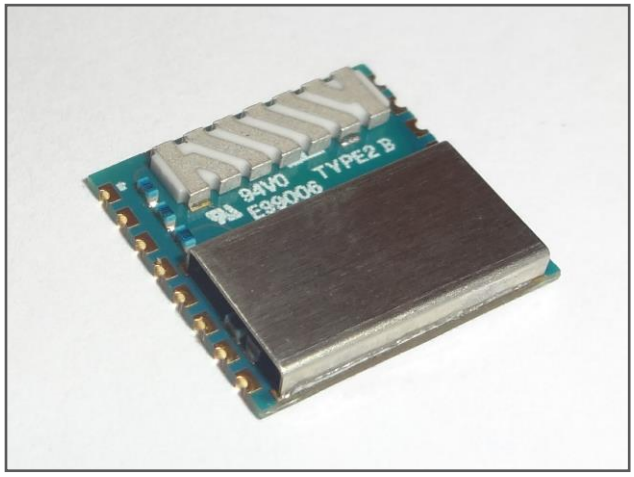
SPLML-868 and SP1ML-915

SPIRIT1 868 and 915 MHz Low Power RF Modules

PRELIMINARY DATASHEET



Features

- Complete RF ready Spirit1 module
- Integrated antenna and crystal
- STM32L microcontroller up to 32 MHz
- Low power consumption
- UART interface with AT command set
- Operates from a single 1.8V to 3.6V supply
- 863 to 870 MHz operation (SP1ML-868)
- 902 to 928 MHz operation (SP1ML-915)
- Output power up to +11.6dBm
- Data rates up to 500kbps
- Modulation schemes: 2-FSK, GFSK, GMSK, OOK, and ASK
- Compact size: 14mm x 13.4mm x 2.5mm
- Operating temperature: -40 °C to 85 °C
- FCC and CE regulatory approvals

Applications

- Serial cable replacement
- Home automation
- M2M industrial control
- Service diagnostic
- Data acquisition equipment
- Machine control
- Sensor monitoring
- Security systems
- Mobile health and medical

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1 Description

The SP1ML-868 and SP1ML-915 are low power RF modules based on the SPIRIT1 radio, with integrated voltage regulation, antenna, crystal and microcontroller in a compact surface mount module form-factor. The module allows OEMs to easily add wireless capability to any electronic device without requiring in-depth RF experience, and has the necessary FCC modular approvals and CE compliance to reduce time to market.

The UART host interface allows simple connection to an external microcontroller. Access to module features is provided through an extended AT command set. A simple cable replacement model allows the module to be used similarly to a standard serial interface.

The microcontroller serial wire debug signals are available and allow the standard firmware to be replaced by a user application, enabling use as a wireless application module where no external microprocessor system is required. Select STM32L GPIO and peripherals are available for interfacing to external devices in the user application, and advanced features of the SPIRIT1 radio are also accessible.

2 Hardware specification

General conditions (V_{IN} = 3 V and T_A = 25°C).

2.1 Recommended operating conditions

Table 1. Recommended operating conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_A	Operating ambient temperature range	-40	-	85	°C
V_{DD}	Operating supply voltage	1.8	3	3.6	V
FREQ	RF frequency (SP1ML-868)	863	-	870	MHz
FREQ	RF frequency (SP1ML-915)	902	-	928	MHz

2.2 Absolute maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_{STG}	Storage temperature range	-40	-	85	°C
V_{DD}	Operating supply voltage	-0.3	-	3.9	V
V_{IO}	I/O pin voltage	-0.3	-	5.5	V

2.3 I/O operating characteristics

Table 3. I/O operating characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{IL}(1)	I/O input low level voltage	-0.3	-	0.3 V_{DD}	V
V_{IH}(1)	I/O input high level voltage	0.7 V_{IN}	-	V_{DD}+0.3	V

1. For more details see the STM32L151RB datasheet, I/O port characteristics.

2.4 Current consumption

Table 4. Current consumption

Symbol	Parameter	Test Conditions	Typ.	Unit
I_{DD}	Supply current	Operating mode Tx, +11dBm, 2-FSK, 915 MHz	20	mA
		Operating mode Tx, -7dBm, 2-FSK, 915 MHz	8	mA
		Operating mode Rx, 915 MHz	11	mA
		Operating mode – Idle	800	µA
		Command mode	1.3	mA
		Standby	1.4	µA

2.5 RF compliance limits

The RF compliance limits are those tested for FCC and CE certification. These limits are enforced by the factory loaded firmware.

Table 5. RF compliance limits

Modulation	Standards	Parameter	Max.	Unit
2-FSK GFSK MSK	FCC Part 15.207 (1) FCC Part 15.247 (1) EN 300 220-2 V2.4.1 (2) EN 301 489-01 V1.9.2 (2) EN 301 489-03 V1.4.1 (2)	Data rate	500	kbps
		Output power	+11.6	dBm
OOK ASK	FCC Part 15.207 (1) FCC Part 15.249 (1) EN 300 220-2 V2.4.1 (2) EN 301 489-01 V1.9.2 (2) EN 301 489-03 V1.4.1 (2)	Data rate	250	kbps
		Output power	+8.5	dBm

1. FCC standards are only applicable to the SP1ML-915 module.
2. EN standards are only applicable to the SP1ML-868 module.

2.6 Pin assignment

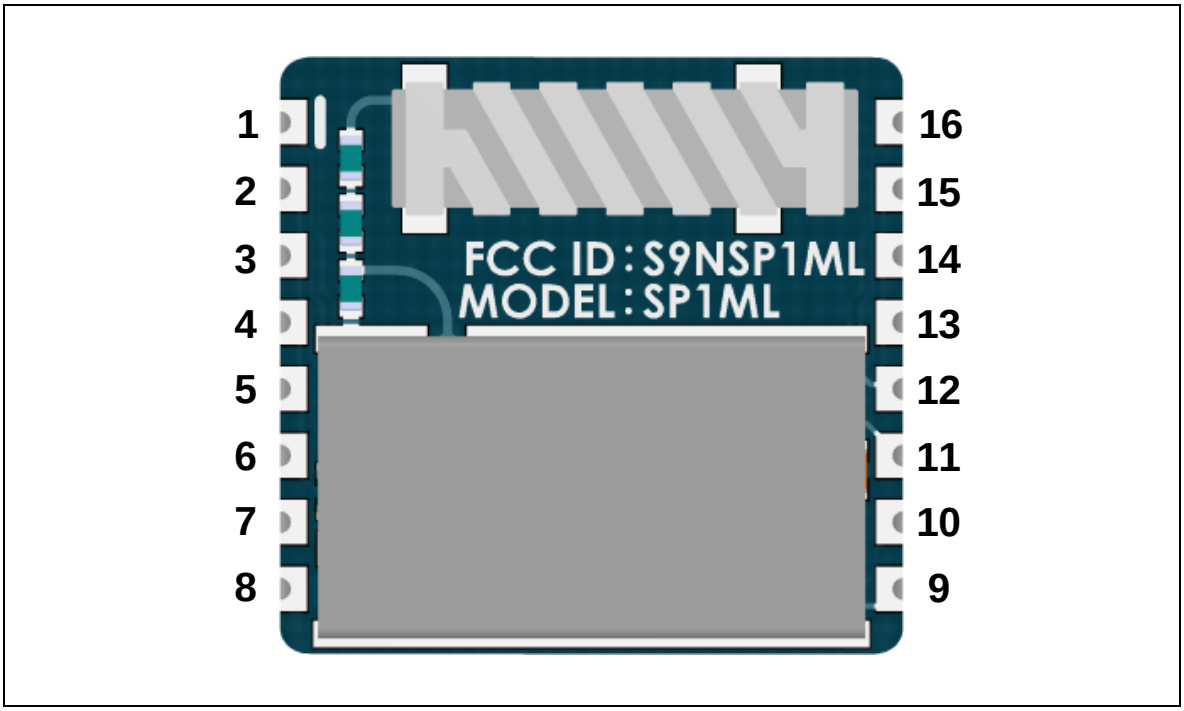
Table 6. Pin assignment

Pin	Name	Type	Description	STM32L pin[1]
1	TXRXLED	O	Active low Tx/Rx LED drive	PA2
2	WKUP	I/O	Wake up module from shutdown	PA0
3	GPIO0	I/O	General purpose input/output 0	PB15
4	GPIO1	I/O	General purpose input/output 1	PB14
5	MODE0	I/O	Protocol mode selection 0[2]	PB13
6	MODE1	I/O	Protocol mode selection 1[2]	PB12
7	VDD	Power	Supply input voltage	-
8	GND	Power	Ground	-
9	SWDIO	I/O	Serial wire I/O	PA13
10	SWCLK	I	Serial wire clock	PA14
11	BOOTMODE	I	Boot mode selection	BOOT0
12	RESET	I	Reset input, active low	NRST
13	TXD	O	UART transmit data	PA9
14	RXD	I	UART receive data	PA10
15	RTS	O	UART request to send	PB6
16	CTS	I	UART clear to send	PB7

1. For more details see the STM32L151RB datasheet, Pin descriptions section. Alternate functions of any given pin are dependent on the user application firmware that is loaded into the module and is beyond the scope of the document.
2. Refer to Hardware design section for details of protocol mode selection.

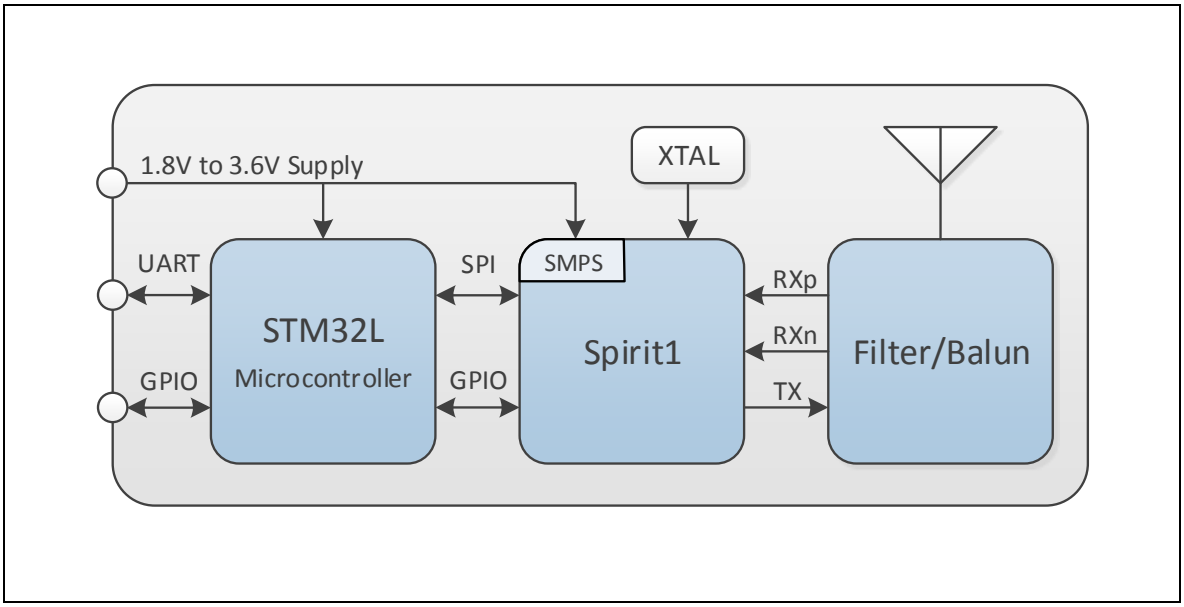
2.7 Pin placement

Figure 1. Pin placement



2.8 Hardware block diagram

Figure 2. Hardware block diagram



3 Hardware design

3.1 Pin usage

If used with the default firmware and interfaced to a host MCU, at a minimum the SP1ML module requires power, ground and UART transmit and receive signals to be connected. Other signals are optional and provide additional functionality. These signals are outlined in the following table. Unused signals must not be connected.

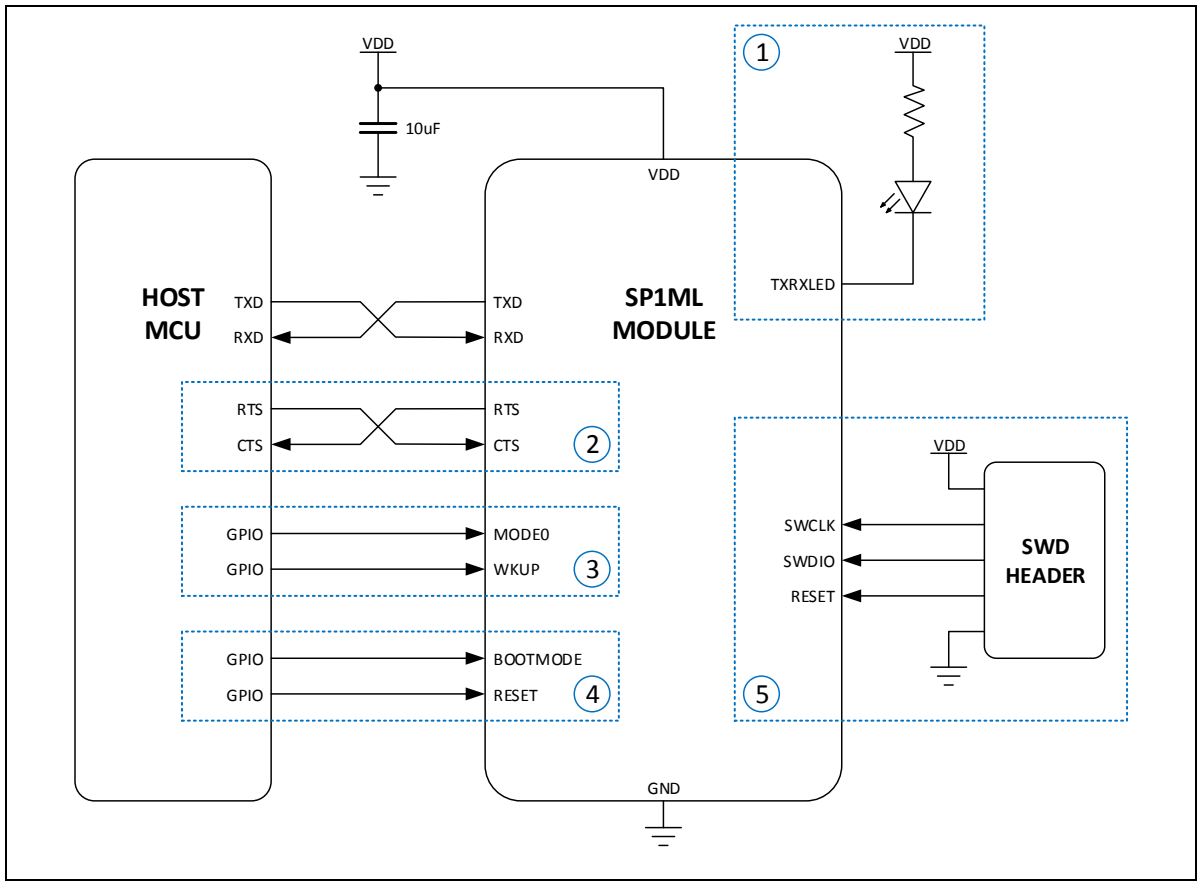
Table 7. Module pin usage

Pin	Name	Description	Optional
1	TXRXLED	An active-low open drain output that can drive an external LED for TX/RX activity status indication.	Yes
2	WKUP	Drive this signal low to put the module into a low power shutdown mode. Float or drive the signal high to wake the module.	Yes
3	GPIO0	Reserved for future use, do not connect.	Yes
4	GPIO1	Reserved for future use, do not connect.	Yes
5	MODE0	Drive this signal low to force the module into *operating mode*. Drive this signal high to force the module into *command mode*. This enables faster switching between modes and obviates the need for escape sequences.	Yes
6	MODE1	Reserved for future use, do not connect.	Yes
7	VDD	Connect to power supply, 1.8V to 3.6V.	No
8	GND	Connect to system ground.	No
9	SWDIO	These signals are the serial wire debug (SWD) interface to the STM32L microcontroller, supporting the development and loading of custom firmware.	Yes
10	SWCLK		Yes
11	BOOTMODE	Drive this signal high at power up or reset to start the boot loader and allow device firmware update over the UART interface.	Yes
12	RESET	Drive this signal low to hold the module in reset. Drive this signal high to release the module from reset.	Yes
13	TXD	Connect to the host system UART RXD input.	No
14	RXD	Connect to the host system UART TXD output.	No
15	RTS	Connect to the host system UART CTS output if flow control is required.	Yes
16	CTS	Connect to the host system UART RTS input if flow control is required.	Yes

3.2 Typical application circuit

In a typical application the SP1ML module is connected to a host MCU using a standard UART, with transmit and receive signals. This is illustrated in the following diagram.

Figure 3. Typical application circuit



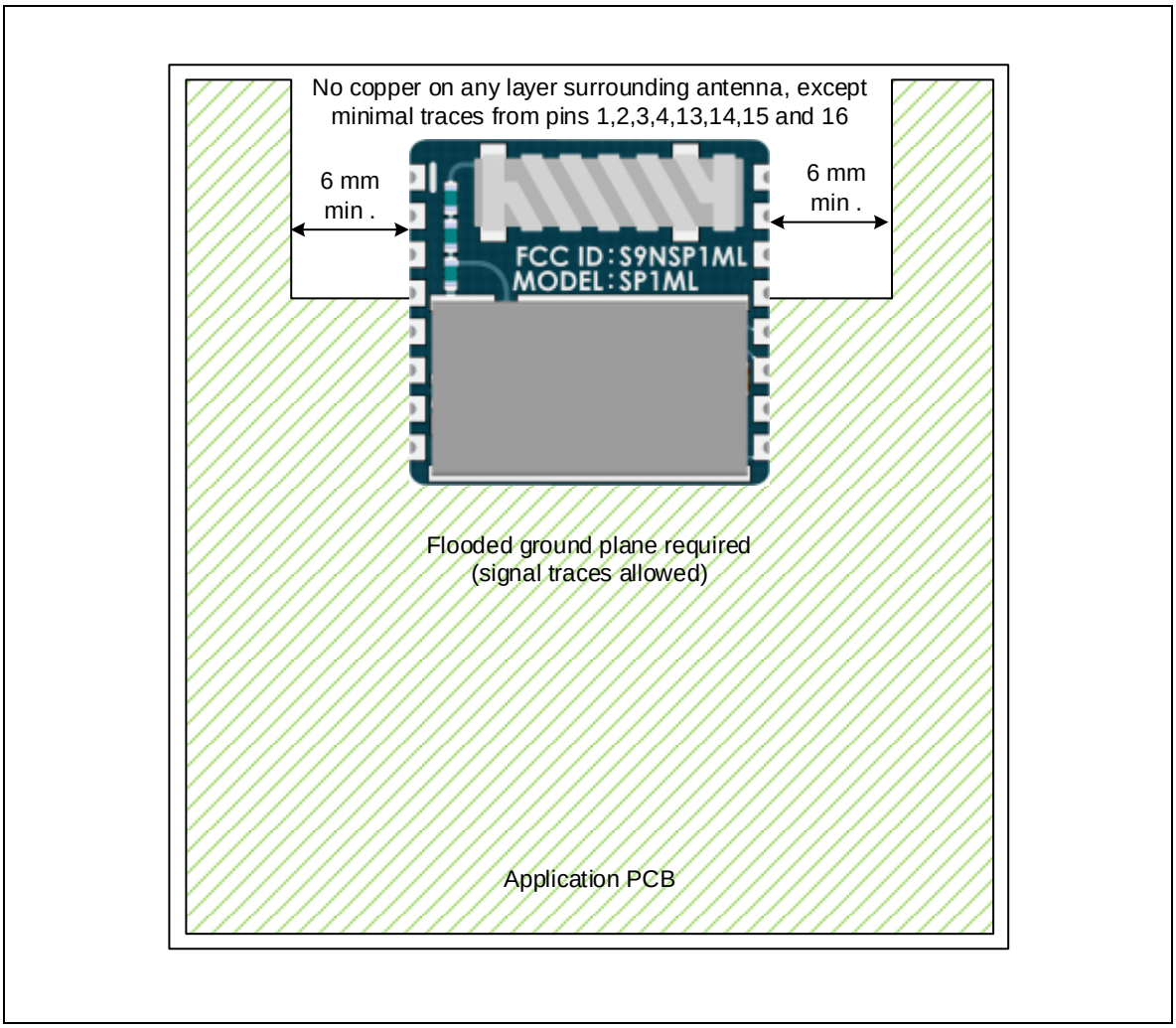
Optional Functionality

1. The TXRXLED signal is an active-low open drain output that can be used to drive an external LED for status indication when data is sent or received.
2. The RTS and CTS signals can be connected to the host UART interface if hardware flow control is required.
3. The MODE0 signal provides a hardware method for switching between command and operating modes. The WKUP signal allows the module to be placed into a low power shutdown mode and woken up again.
4. The BOOTMODE AND RESET signals should be connected if module firmware will need to be updated over the UART interface.
5. To support custom module firmware, the serial wire debug signals need to be accessible for programming and debugging.

3.3 Layout guidelines

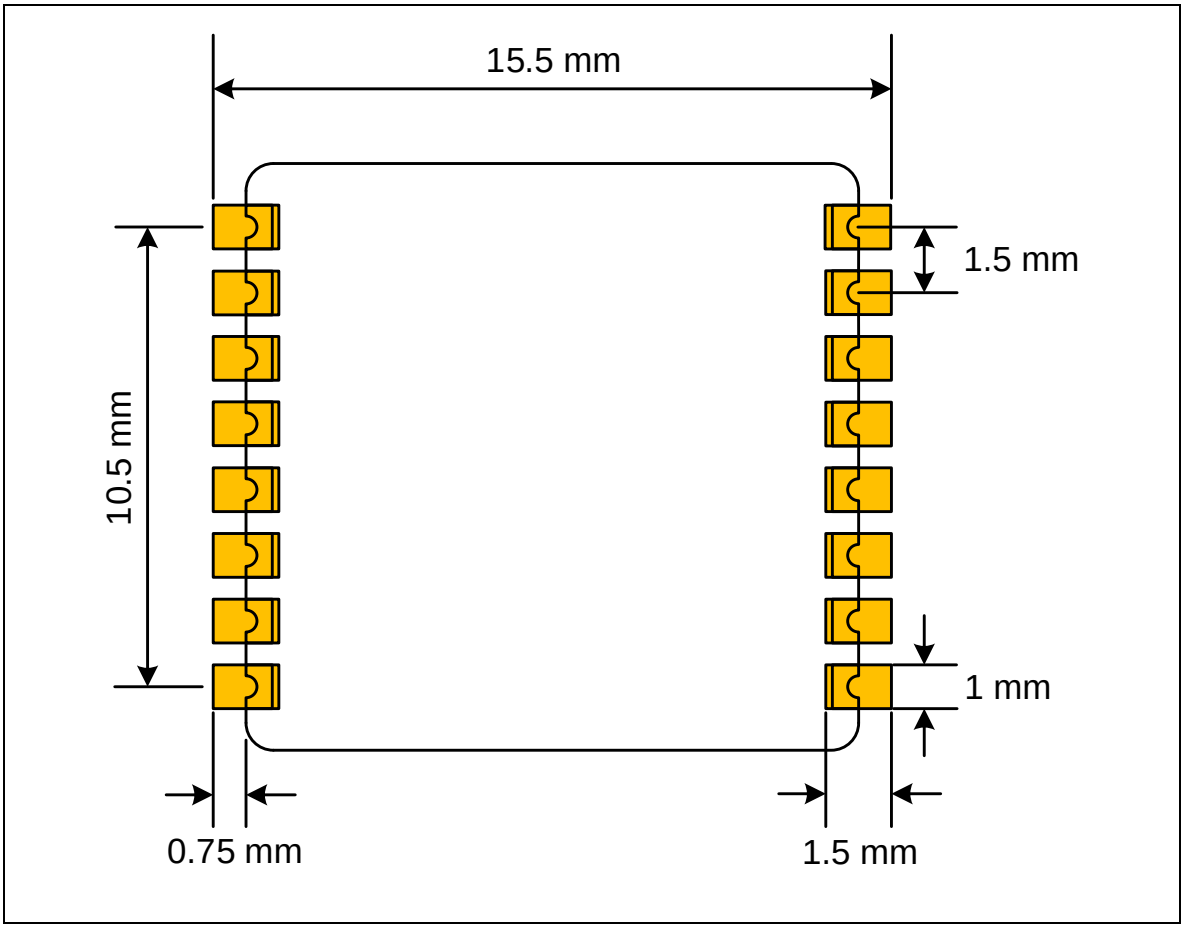
The application PCB requires a flooded ground plane. Care must be taken to ensure there are no traces or ground planes under the area surrounding the antenna, with the exception of minimal width traces from pins 1,2,3,4,13,14,15 and 16 of the module if these are used. It is appropriate to place the module toward the edge of the PCB with no traces or ground planes from the antenna to the board edge.

Figure 4. Layout guidelines



3.4 Recommended footprint

Figure 5. Recommended footprint



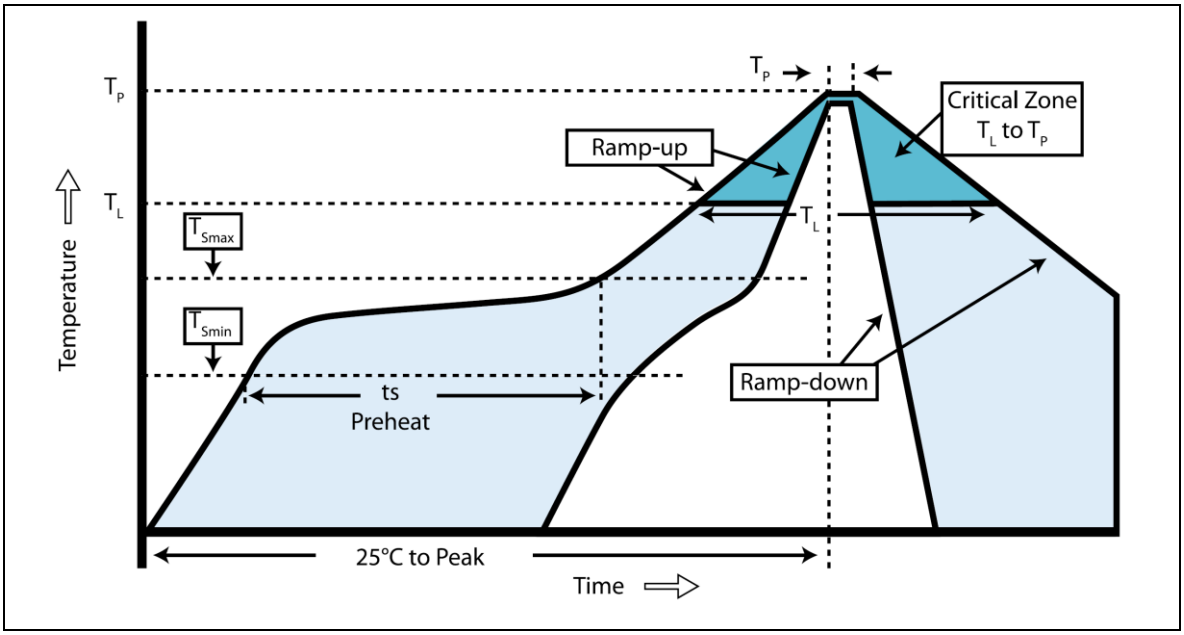
3.5 Module reflow installation

The SP1ML is a surface mount module supplied on a 16-pin, 4-layer PCB. The final assembly recommended reflow profile is indicated below, based on IPC/JEDEC JSTD-020C, July 2004 recommendations.

Table 8. Soldering profile

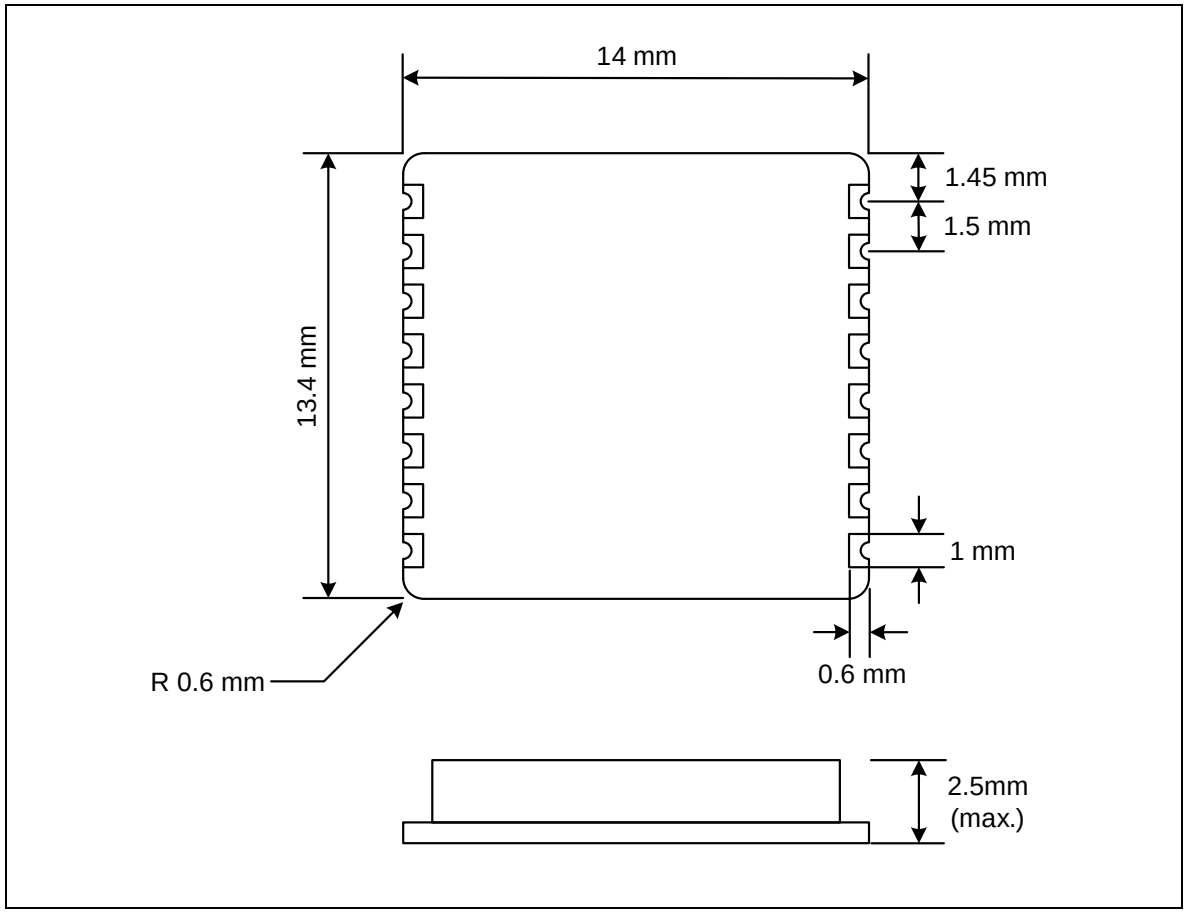
Profile feature	Lead-free assembly
Average ramp-up rate (T_{SMAX} to T_P)	3 °C/sec max
Preheat: – Temperature min. (T_S min.) – Temperature max. (T_S max.) – Time (t_s min. to t_s max.)(t_s)	 150 °C 200 °C 60-100 sec
Time maintained above: – Temperature T_L – Temperature T_L	 217 °C 60-70 sec
Peak temperature (T_P)	240 °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 6. Soldering profile



4 Mechanical data

Figure 7. Mechanical data



4.1 RoHS compliance

ST modules are RoHS compliant and comply with ECOPACK® norms.

5 Regulatory compliance

5.1 FCC certification

This module has been tested and found to comply with the FCC part 15 rules. 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 may 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) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

Modular approval

FCC ID: S9NSP1ML

In accordance with FCC part 15, the SP1ML-915 is listed as a modular transmitter device.

This module is evaluated for stand-alone use only. Finished products incorporating multiple transmitters must comply with colocation and RF exposure requirements in accordance with FCC multi-transmitter product procedures. Collocated transmitters operating in portable RF Exposure conditions (e.g. <20cm from persons including but not limited to body worn and hand held devices) may require separate approval.

5.2 CE certification

The module has been certified according to the following standards:

EN 300 220-2 V2.4.1
EN 301 489-01 V1.9.2
EN 301 489-03 V1.4.1

5.3 Labeling instructions

When integrating the SP1ML-915 into the final product, the OEM must ensure that the FCC labeling requirements are satisfied. A statement must be included on the exterior of the final product which indicates the product includes a certified module. The label should state the following (or similar wording that conveys the same meaning):

Contains FCC ID: S9NSP1ML

OR *This product contains FCC ID: S9NSP1ML*

The OEM must include the following statements on the exterior of the final product unless the product is too small (e.g. less than 4 x 4 inches):

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including any interference that may cause undesired operation.

5.4 Product manual instructions

This section applies to OEM final products containing the SP1ML-915 module, subject to FCC compliance. The final product manual must contain the following statement (or a similar statement that conveys the same meaning):

WARNING: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment

In the case where an OEM seeks Class B (residential) limits for the final product, the following statement must be included in the final product manual:

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. 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. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

In the case where an OEM seeks the lesser category of a Class A digital device for the final product, the following statement must be included in the final product manual:

> *NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his expense.*

6 Ordering Information

Table 9. Ordering information

Order code	Description
SP1ML-868	868 MHz Spirit 1 antenna module (Region 1, Europe)
SP1ML-915	915 MHz Spirit 1 antenna module (Region 2, The Americas)

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