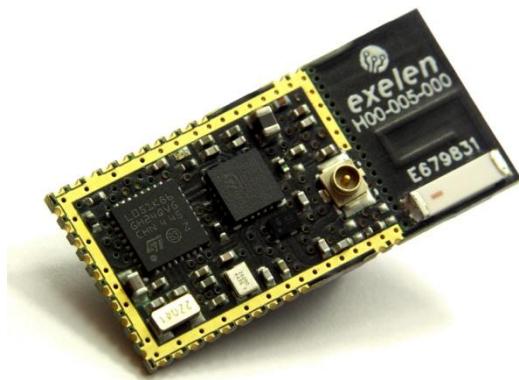


Ultra-low power sub-1GHz RF module with integrated microcontroller & PCB antenna

DATASHEET



FEATURES

- 868 MHz SRD & 915 ISM bands
- Up to 500 kbps data rate
- Integrated PCB antenna
- Ultra-low power STM32L0 microcontroller
- Simple control with AT command set
- SWD interface for custom firmware development by the user
- USART, I²C, SPI and USB interfaces, up to 16 GPIO pins and up to 6 analog pins (ADC) are available for extended operations
- Real-time clock (RTC)
- CE (R&TTE) certified
- RoHS compliant

KEY SPECIFICATIONS

- Compact design: 14 x 30 x 2.45 mm
- 1.8 – 3.6V single supply
- Power consumption: 22 mA (Tx @ +11 dBm), 8 mA (Tx @ -7 dBm), 11 mA (Rx)
- 32-MHz Cortex-M0+ microcontroller with 64 kB Flash memory (STM32L0 series)

APPLICATIONS

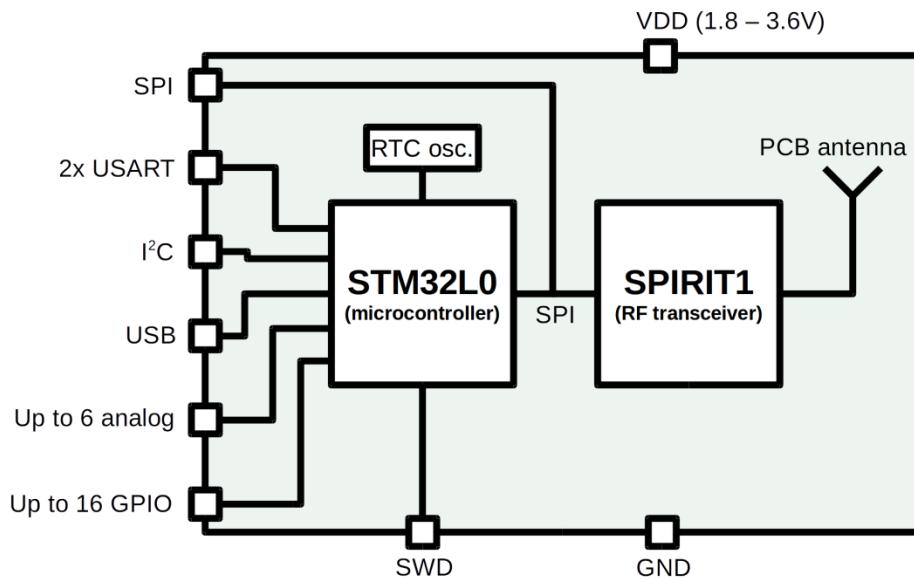
- Wireless sensors network
- Battery-powered wireless devices
- Point-to-point serial data link
- Home automation
- Industrial monitoring and control
- Alarm systems
- Wireless metering, Wireless M-Bus

DESCRIPTION

The XLN-RF-868-A module is an ultra-low power RF module operating in the 868 MHz SRD band. Thanks to its small footprint, its integrated PCB antenna and its easy-to-use interface, integration of RF connectivity into your design is quick and seamless, reducing time-to-market of RF-enabled products.

The module includes a STM32L0 microcontroller clocked at up to 32 MHz coupled with a SPIRIT1 RF transceiver, with a standard firmware allowing easy RF configuration, transmission and reception through the USART interface. In addition, the microcontroller's standard Serial Wire Debug (SWD) interface is also made available to the user, so that custom applications can also be programmed. The microcontroller's USART, I²C, SPI and USB interfaces are also available to the user, as well as several GPIO and analog input pins to control peripherals, acquire data and communicate with other systems, so that no additional microcontroller is needed in most designs.

The XLN-RF-868-A module is already CE (R&TTE) certified, so that no costly RF certification is required from the user.



XLN-RF-868-A module block diagram

SPECIFICATIONS

RF band	868 MHz (SRD860), 915 MHz ISM
RF modulations	ASK, 2-FSK, GFSK, GMSK, MSK, OOK
Data rate	1 to 500 kb/s
Rx sensitivity	-118 dBm (2-FSK at 1.2 kb/s), -95 dBm (MSK at 250 kb/s)
Tx output power	-30 to +11 dBm
Antenna	Integrated PCB antenna
Encryption	128-bit AES (hardware accelerated)
Power consumption	Sleep: 2 µA Tx: 8 mA @ -7 dBm, 22 mA @ +11 dBm Rx: 11 mA
Supply voltage	1.8 – 3.6V (single supply)
RF transceiver	SPIRIT1 (ST Microelectronics)
Microcontroller	STM32L052 (ST Microelectronics) Cortex-M0+, up to 32 MHz, 64 kB Flash, 8 kB RAM
Included functionalities	Real-time clock (20 ppm accuracy)
Interfaces	1x I²C, 1x SPI, 2x USART, 1x USB 2.0, 1x SWD Up to 16 GPIO pins Up to 6 analog pins (ADC)
RF standards compatibility	EN13757-4 (Wireless M-BUS)
Dimensions	14 x 30 x 2.45 mm
Operating temperature	-30 to +85 °C
Certifications	CE (R&TTE, EN 300 220), 868 MHz SRD only
Environmental compliance	RoHS

Notice: The specifications provided in this document are only informative and can be changed by Exelen GmbH at any time without notice.

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1 Hardware specifications

1.1 Absolute maximum ratings

Symbol	Description	Min.	Max.	Unit
T_a	Ambient operating temperature	-40	85	°C
T_s	Storage temperature	-40	85	°C
V_{DD}	Supply voltage	-0.3	3.9	V
V_{IOst}	STM32 I/O pins voltage	-0.3	5.5	V
V_{Iosp}	SPIRIT1 I/O pins voltage	-0.3	3.9	V
I_{IO}	I/O pins current	-16	16	mA

Table 1 - Absolute maximum ratings

1.2 Normal operating conditions

Symbol	Description	Min.	Typ.	Max.	Unit
V_{DD}	Supply voltage	1.8	3.0	3.6	V
V_{IL}	Input low level voltage	-0.3	0	0.3 V_{DD}	V
V_{IH}	Input high level voltage	0.7 V_{DD}	V_{DD}	$V_{DD} + 0.3$	V
I_{IO}	I/O pins current	-16	-	16	mA

Table 2 - Normal operating conditions

1.3 Pinout

The pinout of the XLN-RF-868-A module is described on Figure 1 and Table 3.

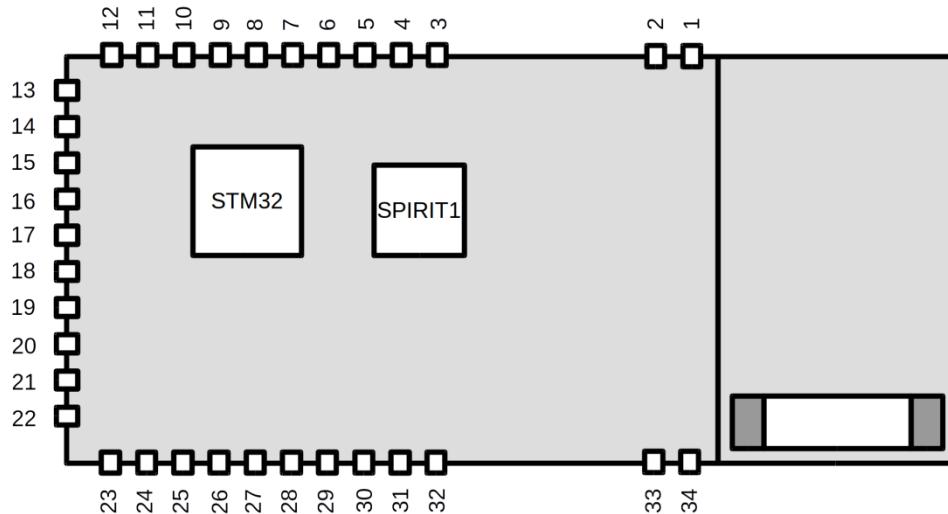


Figure 1 - XLN-RF-868-A module pinout

Pin #	Pin name	Type	SPIRIT1 pin	STM32L0 pin	Functions
1	GND	Supply	-	-	Ground
2	GND	Supply	-	-	Ground
3	RF.GPIO3	I/O	GPIO_3	PB2	SPIRIT1 GPIO / STM32 GPIO
4	GPIO1.PA8	I/O	-	PA8	STM32 GPIO
5	USART1.TX	I/O	-	PA9	USART1 TX / STM32 GPIO
6	USART1.RX	I/O	-	PA10	USART1 RX / STM32 GPIO
7	USB1.DM	I/O	-	PA11	USB1 Data – / STM32 GPIO
8	USB1.DP	I/O	-	PA12	USB1 Data + / STM32 GPIO
9	SWDIO	I/O	-	PA13	Serial Wire Debug I/O / STM32 GPIO
10	GND	Supply	-	-	Ground
11	SWCLK	I/O	-	PA14	Serial Wire Debug CLK / STM32 GPIO
12	VCC	Supply	-	-	Supply Voltage (1.8 – 3.6V)
13	RF.SDN	I/O	SDN	PA15	SPIRIT1 Shutdown Pin / STM32 GPIO
14	BOOT0	I/O	-	BOOT0	STM32 Bootloader Mode (BOOT0)
15	GPIO1.PB3	I/O	-	PB3	STM32 GPIO
16	GPIO1.PB4	I/O	-	PB4	STM32 GPIO
17	GPIO1.PB5	I/O	-	PB5	STM32 GPIO
18	I2C1.SCL	I/O	-	PB6	I2C Clock / STM32 GPIO
19	I2C1.SDA	I/O	-	PB7	I2C Data / STM32 GPIO
20	VCC	Supply	-	-	Supply Voltage (1.8 – 3.6V)
21	VCC	Supply	-	-	Supply Voltage (1.8 – 3.6V)
22	GND	Supply	-	-	Ground
23	GPIO1.PB8	I/O	-	PB8	STM32 GPIO
24	RF.GPIO2	I/O	GPIO_2	PA0	SPIRIT1 GPIO / STM32 GPIO
25	GPIO1.PA1	I/O	-	PA1	STM32 GPIO
26	USART2.TX	I/O	-	PA2	UART2 TX / STM32 GPIO
27	NRST	RST	-	NRST	STM32 reset pin (active low)
28	USART2.RX	I/O	-	PA3	UART2 RX / STM32 GPIO
29	SPI1.CLK	I/O	SCLK	PA5	SPI clock
30	SPI1.MOSI	I/O	MOSI	PA7	SPI Master Out-Slave In
31	SPI1.MISO	I/O	MISO	PA6	SPI Master In-Slave Out
32	SPI1.CS1	I/O	CSn	PA4	SPI Chip Select
33	GND	Supply	-	-	Ground
34	GND	Supply	-	-	Ground

Table 3 - Module pinout details

1.4 Simplified schematics

A simplified schematic of the module is shown on Figure 2.

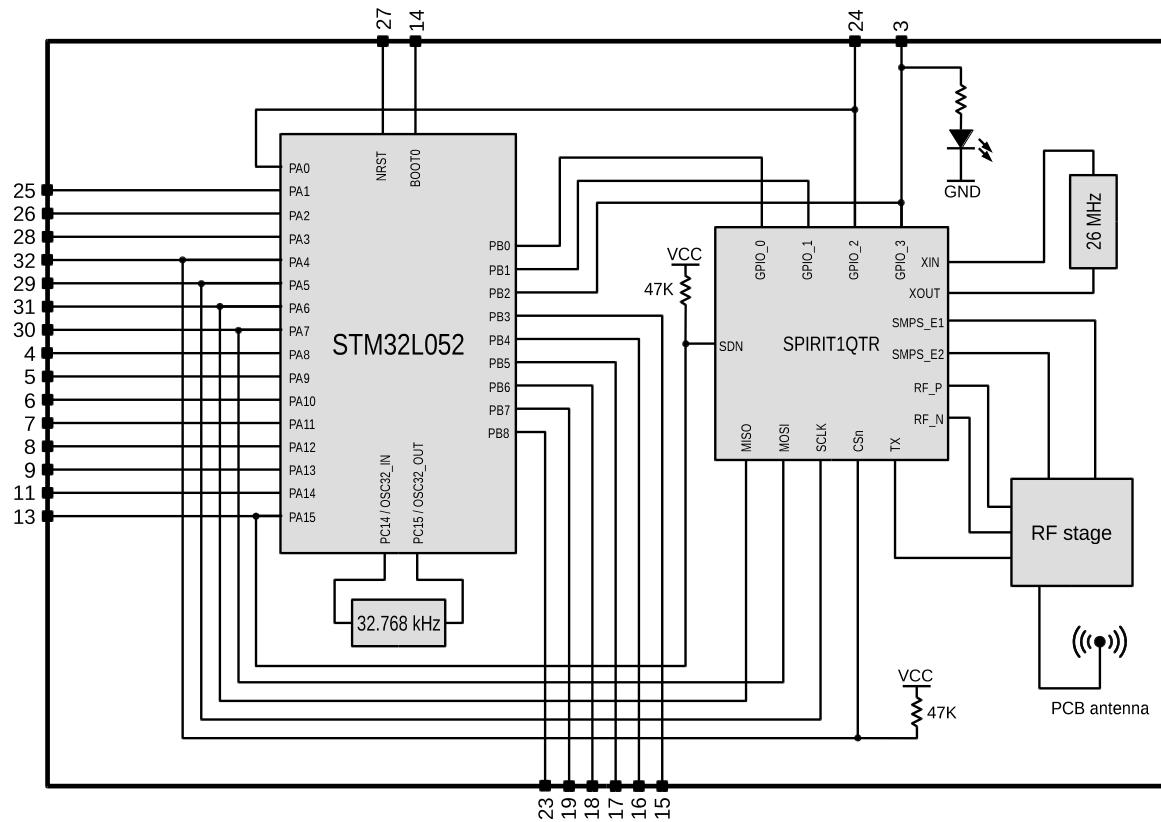


Figure 2 - Simplified schematic of XLN-RF-868-A module

1.5 Recommended PCB footprint

The recommended PCB footprint for the XLN-RF-868-A module is shown on Figure 3.

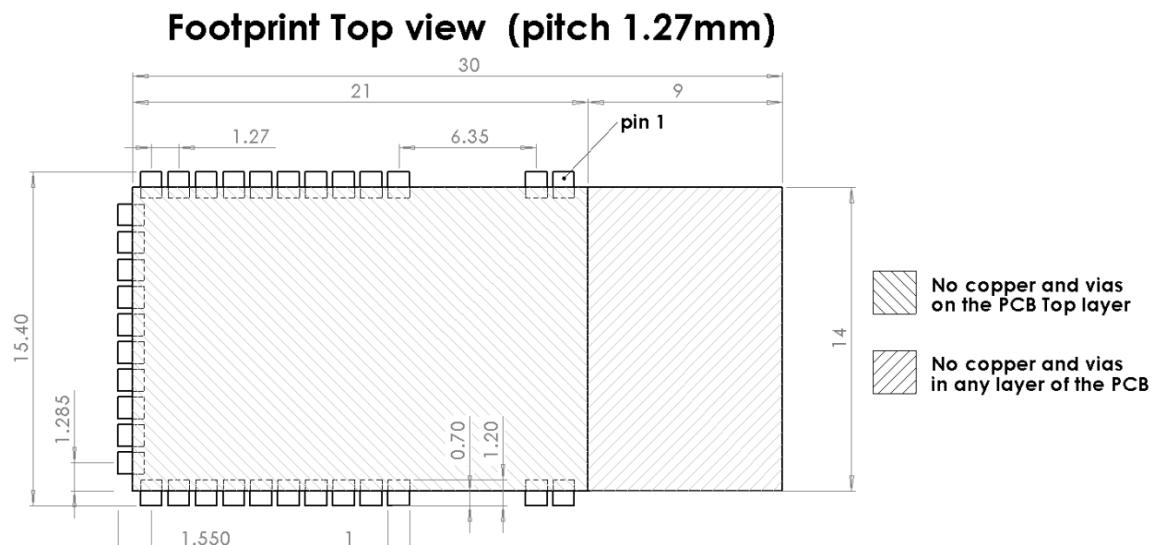


Figure 3 - Recommended PCB footprint

2 Module operation

The XLN-RF-868-A module can be operated either with the included firmware, which offers basic operations, or with a custom user firmware.

2.1 Operation with included firmware

The firmware included in the XLN-RF-868-A module allows basic radio configuration and data transmission/reception over the UART1 interface of the STM32 microcontroller (pins 5 and 6 of the XLN-RF-868-A module).

2.1.1 UART1 configuration

At power up or after a reset, the UART interface has the following configuration:

- Data bits: 8
- Stop bit: 1
- Parity: none
- Bitrate: 115200
- Flow control: disabled

The bitrate and the flow control can be changed by changing the corresponding S register (see Table 4).

2.1.2 Operating modes

The firmware operates in two distinct modes: the command mode (for configuration) and the data mode (for data transmission and reception), described below.

2.1.2.1 Command mode

This is the mode in which the module's firmware boots into after power up or reset.

The command mode allows the user to configure the module by using Hayes-like AT commands.

An AT command is a character string starting with the characters "AT" and ending with a CR-LF (carriage return, line feed) sequence.

Examples of AT commands:

ATE1	<i>Enables local echo of characters in command mode</i>
ATS1=10000	<i>Sets S register 1 (RF bitrate) to value 10000</i>
ATS2?	<i>Reads the value of S register 2 (RF modulation)</i>
ATO	<i>Enter data mode</i>

The list of supported AT commands is shown in Table 4.

Command	Description
ATE<n>	<p>Echo on/off. When echo is on, the XLN-RF-868-A module will transmit back to the host every character received on the UART interface when in AT commands mode.</p> <p>Possible values for <n> :</p> <ul style="list-style-type: none"> • 0 : echo off • 1 : echo on <p>Example:</p> <pre>ATE1</pre> <p>Reply from module:</p> <pre>OK</pre>
ATI<n>	<p>Returns information about the module</p> <p>Possible values for <n> :</p> <ul style="list-style-type: none"> • 0 : module type • 1 : module manufacturer • 2 : firmware revision <p>Example :</p> <pre>ATI1</pre> <p>Reply from module:</p> <pre>Exelen GmbH</pre>
ATO	<p>Leaves command mode and enters data mode.</p> <p>After this command is received, the module will be in data mode, meaning that data received on the UART interface will be transmitted by radio.</p> <p>To return to command mode from data mode, the escape sequence shall be sent to the module. See section 2.1.2.2 for more details.</p> <p>Example :</p> <pre>ATO</pre> <p>Reply from module: none</p>
ATR	<p>Loads and applies the default settings.</p> <p>Example:</p> <pre>ATR</pre> <p>Reply from module:</p> <pre>OK</pre>
ATS<n>? ATS<n>=<x>	<p>Reads or writes configuration registers.</p> <p>ATS<n>? reads and returns the value of register <n>.</p> <p>ATS<n>=<x> sets the value of register <n> to <x>.</p> <p><n> and <x> shall be in decimal format.</p> <p>Example:</p> <pre>ATS1=200000</pre> <p>Reply from module:</p> <pre>OK</pre> <p>Example:</p> <pre>ATS0?</pre> <p>Reply from module:</p> <pre>115200</pre> <p>See Table 5 for a list and a detailed description of configuration registers.</p>

Command	Description
AT&S<n>? AT&S<n>=<x>	<p>Reads or writes SPIRIT1 registers directly.</p> <p>AT&S<n>? reads and returns the value of register <n>.</p> <p>AT&S<n>=<x> sets the value of register <n> to <x>.</p> <p><n> and <x> shall be in decimal format.</p> <p>Example: AT&S26=52</p> <p>Reply from module: OK</p> <p>Example: AT&S53?</p> <p>Reply from module: 64</p> <p>WARNING: modifying SPIRIT1 registers may break CE certification compliance. Use at your own risk.</p> <p>See the SPIRIT1 datasheet from STMicroelectronics for a list and a detailed description of configuration registers.</p>

Table 4 - AT commands description

S register id	Description
0	<p>UART bitrate UART bitrate in bits/seconds on the UART1 serial interface.</p> <p>Possible values :</p> <ul style="list-style-type: none"> • 2400 • 9600 • 19200 • 38400 • 57600 • 115200 • 230400 • 460800 • 921600
1	<p>RF bitrate RF bitrate in bits/seconds.</p> <p>Possible values : 1000 to 500000 Default value : 10000</p>
2	<p>RF output power RF output power in dBm * 10.</p> <p>Possible values: 0 to 116 (corresponding to 0 – 11.6 dBm) Default value : 116</p>
3	<p>RF modulation RF modulation to be used.</p> <p>Possible values:</p> <ul style="list-style-type: none"> • 0 : 2-FSK • 1 : GFSK (Gaussian filter BT product of 0.5) • 2 : GFSK (Gaussian filter BT product of 1) • 3 : OOK • 4 : MSK <p>Default value : 0</p>
4	<p>RF frequency RF frequency in Hz.</p> <p>Possible values : 863000000 to 870000000 Default value : 868000000</p>
5	<p>RF frequency deviation RF frequency deviation in Hz (used only for 2-FSK and GFSK modulations).</p> <p>Possible values : 400 to 380000 Default value : 20000</p>
6	<p>RX filter cut-off frequency Cut-off frequency in Hz of the RX digital filter.</p> <p>Possible values :</p> <ul style="list-style-type: none"> • 0 : automatic cut-off frequency (based on selected modulation parameters) • 1100 to 800000 : cut-off frequency in Hz <p>Default value: 0</p>
7-30	Reserved

<i>S register id</i>	<i>Description</i>
31	<p>Hardware flow control Enables/disables hardware RTS/CTS flow control on the UART1 serial interface. Possible values:</p> <ul style="list-style-type: none"> • 0 : RTS/CTS disabled • 1 : RTS/CTS enabled <p>Default value : 0 Note : hardware flow control is strongly recommended to avoid buffer overflows leading to data loss.</p>

Table 5 - S registers description

2.1.2.2 Data mode

In data mode, data received on the UART1 interface are forwarded to the radio for transmission, and data received from the radio are forwarded to the UART1 interface. Two modules can thus be used to create a wireless serial link.

To enter data mode from command mode, use the `ATO` command.

The radio interface is configured to use packets carrying at most 48 bytes of payload. This means that as soon as 48 bytes of data are received on the UART interface, they are forwarded to the SPIRIT1 for transmission. In addition, if less than 48 bytes are received on the UART within 50 milliseconds, they are transmitted anyway.

2.2 Custom firmware

A custom firmware can be developed by the user and programmed into the microcontroller's FLASH memory through the SWD interface or using the ROM bootloader, through SPI or UART (see STMicroelectronics application note AN2606).

3 Revision history

Date	Version	Changes
19.03.2015	0.1	First draft
25.03.2015	0.2	- Improved description of S registers - Added UART configuration
26.03.2015	0.3	- Fixed module dimension - Added document revision history

Table 6 - Document revision history

The specifications and information provided by STMicroelectronics in the datasheet and errata sheet of the STM32L052 and SPIRIT1 devices are applicable.

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Exelen GmbH

*Route André Piller 21
1762 Givisiez (FR)
Switzerland*

+41 26 422 48 42

*info@exelen.ch
www.exelen.ch*