EMB-LR1276S
Datasheet

Embit s.r.l.

Document information

Versions & Revisions

Revision	Date	Author	Comments
0.1	2018-10-05	Embit-MDD	Initial release
0.5	2018-10-09	Embit-MDD	Preliminary version
0.7	2019-01-21	Embit-MDD	Preliminary version updated
0.8	2019-02-08	Embit-MDD	Test results added
0.9	2019-02-15	Embit-MDD	Footprint modified
0.95	2019-04-29	Embit-MDD	Typical application circuit modified
1.0	2019-05-01	Embit-MDD	Final release
1.1	2019-09-19	Embit-MDD	Typical application circuit added- modem

Index

1 Introduction

EMB-LR1276S is the new sub-1GHz **Embit**'s wireless module that supports the **LoRaWAN™** long range wireless protocol. It comes in a very small form factor (11.5 x 11.5 mm) and integrates all the costumers needs to develop complete and secure solutions.

It is based on the new **SAMR34 Microchip SiP**, an ultra low power microcontroller combined with a UHF transceiver communication interface.

The **EMB-LR1276S** can be configured as an embedded micro system or a simple data modem for low power applications in the 868MHz radio bands.

It is equipped with up to 256 KB of Flash and up to 40 KB of SRAM. The transceiver supports LoRa and FSK modulation.

The **EMB-LR1276S** can communicate with other devices through a wide range of serial interfaces: UART, I2C, SPI, Full-Speed USB 2.0, digital and analog I/O ports.

The module has an extremely reduced power consumption (less than **1 μA** in Sleep Mode) which makes it a perfect solution to implement long life battery powered devices.

It features a higher power efficiency in transmission with a maximum output power of **+14dBm** (or **+18dBm** with PA Boost).

The **EMB-LR1276S** integrates two crystals, one at 32MHz and one at 32KHz and a **Crypto Uinit** (ATECC608A) to protect the communication between module and external interfaces. The module integrates as well a U.FL connector to easily connect a 50 Ω antenna.

1.1 Specifications

- Operating Voltage: from 1.8V to 3.3V
- MCU: ARM Cortx M0+ CPU running up to 48MHz
- up to 256 KB of Flash
- up to 32 KB of SRAM
- 8 KB low-power RAM with battery backup retention
- Two Pin Serial Wire Debug (SWD) Programming, Test and Debug Interfaces
- RF Output Power: up to +14dBm (+18dBm with PA Boost)
- Sensitivity: down to -136dBm
- LoRa Technology and FSK modulation
- Peripherals: 12-Channel DMAC, Three 16-bit Timer/Counters, 32-bit RTC, Watchdog Timer (WDT), CRC-32 Generator, Full-Speed USB 2.0, up to four Serial Communication interfaces (configurable as UART, I2C, SPI, LIN), one 12-bit ADC with up to 8 channels, up to 17 GPIOs
- 32MHz crystal for RF reference and 32kHz crystal for RTC

- Footprint: 32-pins LGA
- Crypto Unit to protect communication (ATECC608A)
- U.FL connector and Ground-Signal-Ground pads
- Dimensions: 11.50 x 11.50 x 2 mm
- Temperature Range: -40°C to +85°C

1.2 Applications

The device can be used in several applications where LoRa end-devices are needed, such as:
- Internet Of Things (IOT)
- Automated Meter Reading
- Smart Cities
- Home and Building Automation
- Wireless Alarm and Security System
- Machine to Machine (M2M)
- Industrial Monitoring and Control
- Long Range Irrigation System.

2 Description

2.1 Block Diagram

The **EMB-LR1276S** block diagram:
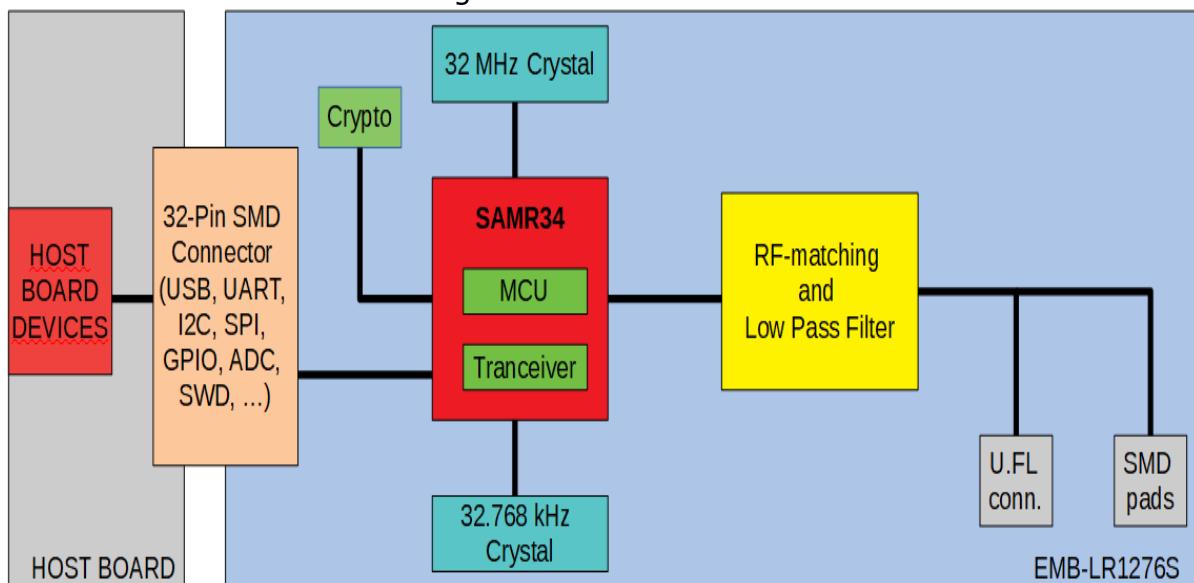
Figure 1. EMB-LR1276S block diagram.

2.2 SAMR34

The **SAMR34** [1] is an ultra low-power microcontroller that uses the 32-bit ARM Cortex-M0+ processor at max. 48MHz with up to 256 KB of Flash and up to 40 KB of SRAM. It is equipped with a UHF transceiver that supports LoRa and FSK modulations able to work from frequencies or 137 MHz to 1020 MHz. It can reach up to +18dBm without external amplification. Operational frequency bands and power limits are defined by local regulations and the LoRa Alliance [2].

It integrates sophisticated power management technologies, such as power domain gating, SleepWalking, ultra low-power peripherals and more, with two software-selectable sleep modes: Idle and Standby.

The Flash program memory can be reprogrammed in-system through the Serial Wire Debug (SWD) interface, which can be used also for on-chip debugging of application code. There is a boot loader as well that runs in the device and can use any communication interface to download and upgrade the application program in the Flash memory.

The MCU includes several peripherals such as: three 16-bit Timer Counters, 32-bit Real Time Counter, Watchdog Timer, Full-Speed USB 2.0, up to four Serial Communication Interfaces (SERCOM), one 12-bit ADC with up to 8 channels.

The transceiver feature the LoRa long range modem that provides ultra-long range spread spectrum communication and high interference immunity whilst minimizing current consumption.

It can achieve a sensitivity of -136dBm in LoRaWAN™ protocol compliant modes. The transmit section offers two integrated power amplifiers for both high efficiency with +14dBm output power, or +18dBm for highest power, depending on the regional regulations. The high sensitivity combined with the integrated power amplifier yields industry leading link budget, making it optimal for any application requiring long range and link robustness. LoRa also provides significant advantages in both blocking and selectivity capabilities over all conventional modulation techniques, improving the traditional design compromises between coverage, interference immunity and energy consumption.

2.3 Antenna

The **EMB-LR1276S** offers two antenna options:

- External antenna connection (optional): 50 Ω single-ended U.FL connector
- Ground-Signal-Ground (GSG) LGA pads: for connection to antenna mounted on the host board

Note: Please refer to the section "Ordering Information".

2.4 Firmware

The **EMB-LR1276S** has an embedded Microchip LoRaWAN™ protocol stack, extended with Embit additional features; moreover, a serial bootloader can be provided to upgrade the device without any additional hardware needed.

2.5 Development tools

To work with the **EMB-LR1276S** module, the following software tools are suggested:

- Atmel Studio 7.0 IDE (minimum version)
- Atmel-ICE debugger and programmer (or any other programmer/debugger supporting Microchip SAMR34 microcontroller).

To quickly get started with Embit modules, Embit also provides ready-to-use firmware for **EMB-LR1276S** that allow the module to act like a simple modem over UART. Through AT-like binary commands it is possible to send/receive data over-the-air and to develop complex applications without the need of writing custom firmware. The protocol and the firmware implementing such feature are called **"EBI" (Embit Binary Interface)** [3].

For more information about **EMB-LR1276S** firmware development and **"EBI"** usage please refer to the documentation, software and hardware tools available on Embit website (www.embit.eu).

3 Size and footprints

3.1 Size

The mechanical dimensions of the **EMB-LR1276S** are 11.5 x 11.5 mm. The thickness is 2 mm.

The module has a total of 32 pins (8 on each of the four edges) with 1 mm pitch and 0.5 x 0.5 mm as dimensions. The positioning is shown in the image below.
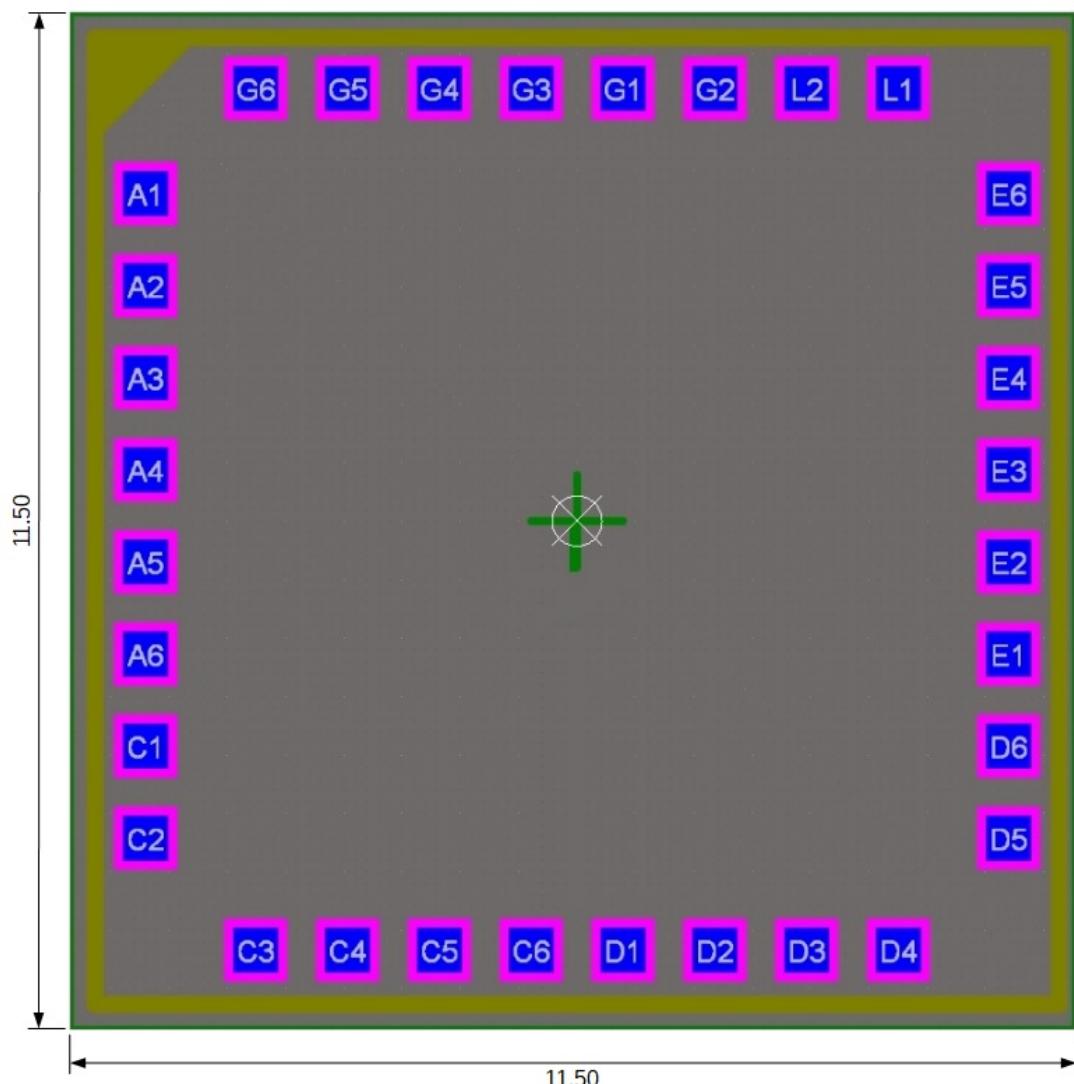
Figure 2. EMB-LR1276S size and pinout (Top View).

3.2 Suggested footprint

The **EMB-LR1276S** suggested footprint consists in 32 LGA pads 0.65 x 0.65 mm in dimensions positioned as following (all sizes are in mm):
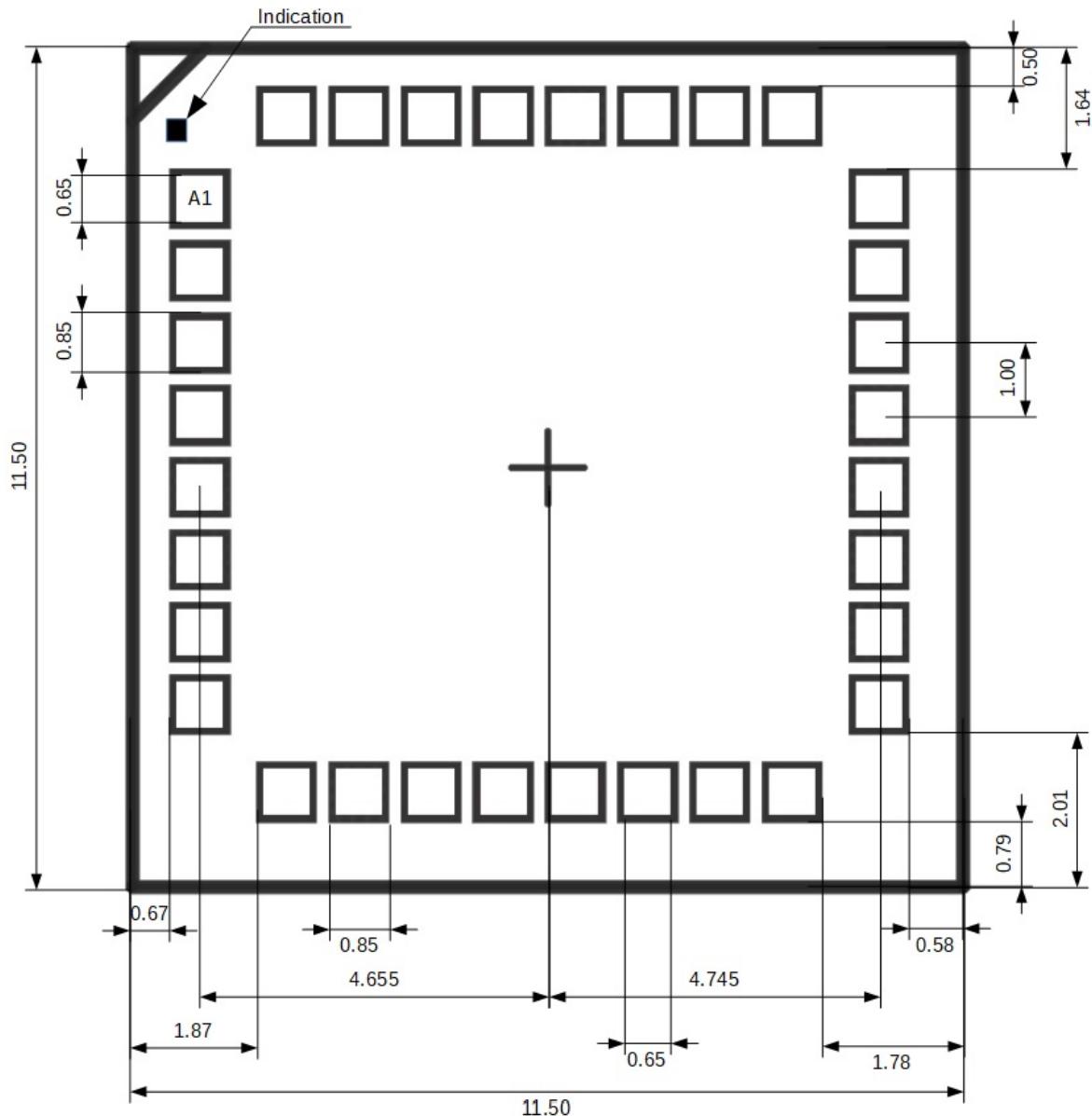
Figure 3. Recommended land pattern (Top View).

3.3 External Antenna Connection

The antenna output of the module is matched to 50 Ω. By using a 50 Ω antenna, no additional matching is required. Connection with antenna should be as short as possible, and must represent a characteristic impedance of 50 Ω. A grounded coplanar waveguide is suggested to minimize the interaction with the external environment.

3.4 Notes

- The area underneath the module **must be** kept free of components (both top and bottom layers) and must be covered with solder resist.
- The PCB top layer underneath the module must be free of nets, power planes and vias. The bottom layer shall provide ground plane.
- The power supply of the module must be as clean as possible; it must be decoupled placing ceramic capacitor as near as possible at the Vcc pins.
- Noisy electronic components (such as switching power supply) must be placed as far as possible and adequately decoupled.
- The ground pins of the module shall be connected to a solid ground plane.
- Taking no account these recommendations may affect the radio performances.

# 4 Connections

4.1 Pin Out Description
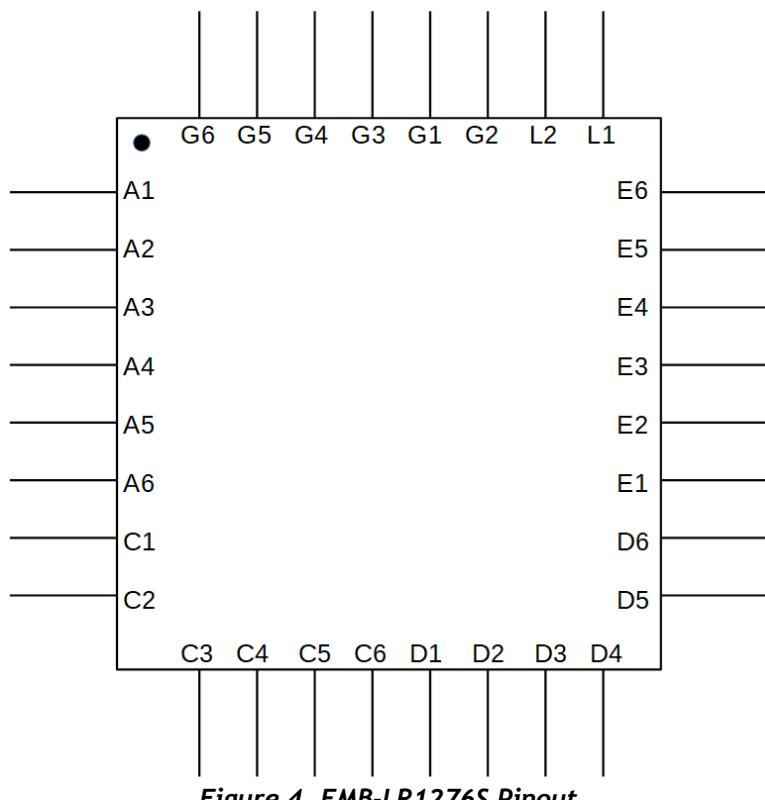
Figure 4. EMB-LR1276S Pinout.

The table below gives the description of the pin out of the **EMB-LR1276S** module.

Number	Pin Name	Type	Description
A1	PA04	Analog Input or Digital I/O	AIN4 / AIN0 / SERCOM 0 / PA04
A2	PA05	Analog Input or Digital I/O	AIN5 / AIN1 / SERCOM 0 / PA05
A3	PA06	Analog Input or Digital I/O	AIN6 / AIN2 / SERCOM 0 / PA06
A4	PA07	Analog Input or Digital I/O	AIN7 / AIN3 /SERCOM 0 / PA07
A5	PA08	Analog Input or Digital I/O	AIN16 / SERCOM 0 / SERCOM 2 / PA08
A6	PA09	Analog Input or Digital I/O	AIN17 / SERCOM 0 / SERCOM 2/ PA09
C1	PA15_XOSCOUT	Digital I/O	SERCOM 2 / SERCOM 4 / PA15
C2	PA14_XOSCIN	Digital I/O	SERCOM 2 / SERCOM 4 / PA14
C3	PA13	Digital I/O	SERCOM 2 / SERCOM 4 / PA13
C4	GND	Power (Ground)	GND
C5	PB23	Digital I/O	SERCOM 5 / PB23
C6	PB03_VBAT	Analog Input or Digital I/O	AIN11 / SERCOM 5 / PB03
D1	PA19	Digital I/O	SERCOM1 / SERCOM 3 / PA19
D2	PA25_USB_P	Digital I/O	SERCOM 3 / SERCOM 5 / USB_P / PA25
D3	PA24_USB_N	Digital I/O	SERCOM 3 / SERCOM 5 / USB_N / PA24
D4	PA30_SWDCLK	Digital I/O - JTAG	SERCOM 1 / PA30 / SWCLK
D5	PA31_SWDIO	Digital I/O - JTAG	SERCOM 1 / PA31 / SWDIO
D6	VCC	Power	+3.3V
E1	VCC	Power	+3.3V
E2	VCC	Power	+3.3V
E3	VCC	Power	+3.3V
E4	PA23	Digital I/O	SERCOM 3 / SERCOM 5 / PA23
E5	RESET#	Reset Input	System Reset Input (active low)
E6	PB02	Analog Input or Digital I/O	AIN10 / SERCOM 5 / PB02
L1	LVSW	Power Output	Linear / Switched regulator mode
L2	VDDCORE	Power Input	On-chip switching mode regulator
G2	PA18	Digital I/O	SERCOM 1 / SERCOM 3 / PA18
G1	GND	Power (Ground)	GND
G3	PA22	Digital I/O	SERCOM 3 / SERCOM 5 / PA22
G4	GND	Power (Ground)	GND
G5	RF_OUT	Output	RF Output
G6	GND	Power (Ground)	GND

Table 1: EMB-LR1276S pin out.

4.2 SERCOM Pins

Sercom0 pins:

Number	Pin Name	Function
A1	PA04	Sercom0_Pad[0]
A2	PA05	Sercom0_Pad[1]
A3	PA06	Sercom0_Pad[2]
A4	PA07	Sercom0_Pad[3]

Table 2: Sercom0 pins.

Sercom2 pins:

Number	Pin Name	Function
A5	PA08	Sercom2_Pad[0]
A6	PA09	Sercom2_Pad[1]
C2	PA14	Sercom2_Pad[2]
C1	PA15	Sercom2_Pad[3]

Table 3: Sercom2 pins.

Sercom3 pins:

Number	Pin Name	Function
G3	PA22	Sercom3_Pad[0]
E4	PA23	Sercom3_Pad[1]
G6	PA18	Sercom3_Pad[2]
G4	PA19	Sercom3_Pad[3]

Table 4: Sercom3 pins.

Sercom5 pins:

Number	Pin Name	Function
E6	PB02	Sercom5_Pad[0]
C6	PB03	Sercom5_Pad[1]
D3	PA24	Sercom5_Pad[2]
D2	PA25	Sercom5_Pad[3]

Table 5: Sercom5 pins.

Sercom pins supporting I2C:

Pins Supporting I2C HS Mode
A5, A6, C3, G3, E4

Table 6: Sercom pins supporting I2C.

Please note that for I2C bus the function for pins SercomX_Pad[0] is SDA and for SercomX_Pad[1] is SCL.

5 Typical Application Circuit

5.1 Micro-embedded approach

A basic application circuit for using **EMB-LR1276S** in a micro-embedded approach is shown below. The **EMB-LR1276S** allows for a minimal number of external components (this decreases the system costs).

A LED indicator (LED1) and a push button (SW1) are used to provide a minimal user interface. The SWD programming / debugging interface, generally speaking, should be routed to a connector on the host board for in-circuit programming.

In addition, a simple supply section based on a 3.3V LDO (IC1) stabilizing the input voltage VIN and a simple reset circuitry are shown. In particular, the reset circuitry allows to:

1. program the MCU of the **EMB-LR1276S** (thanks to the weak pull-up to VCC);

2. mannually reset the MCU, if needed (thanks to SW2).

Moreover, if L1 is mounted the device can switch between Switching and Linear mode (it can be done by software on the fly). If not mounted only Linear mode is available.
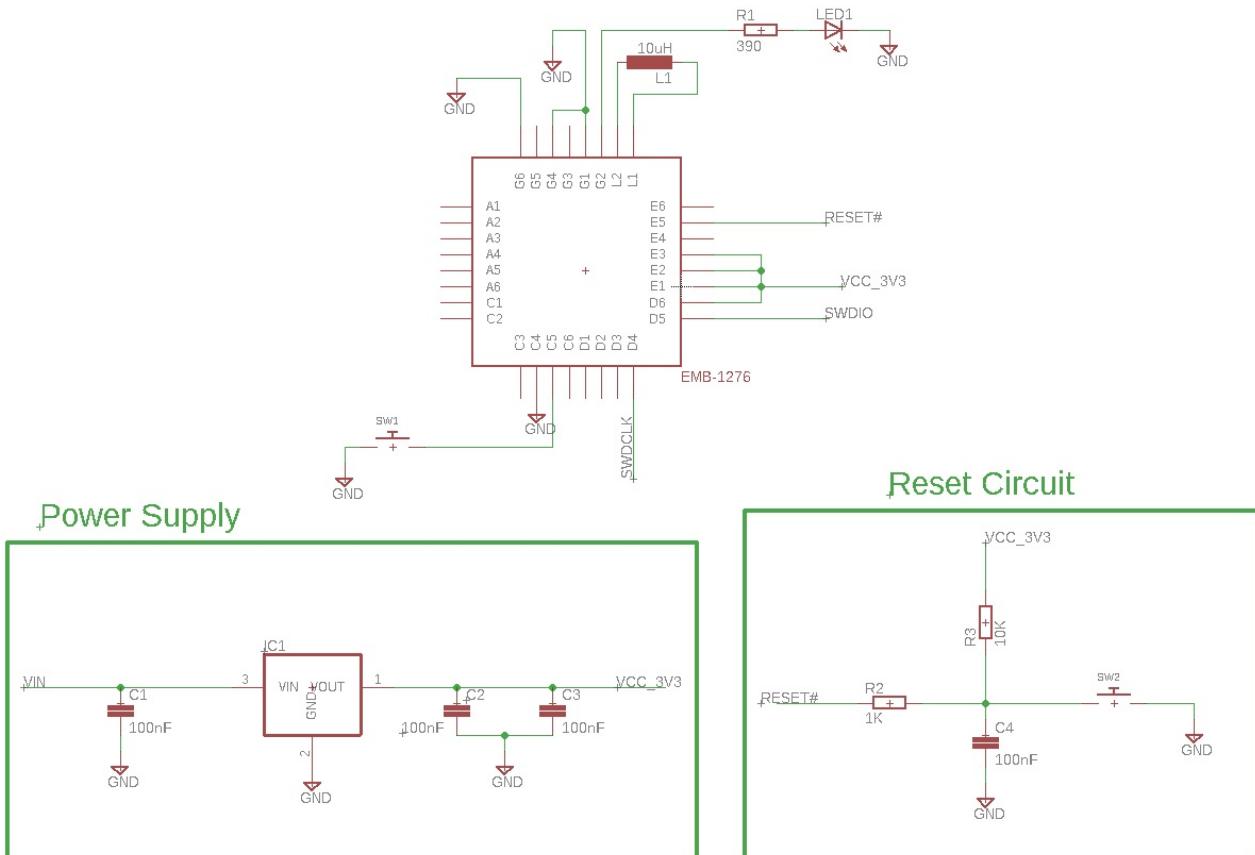

Figure 5.Micro-embedded typical application circuit.

5.2 Modem approach

A basic application circuit for using **EMB-LR1276S** in a modem approach is shown below. The UART lines needs to be connected to the external host.
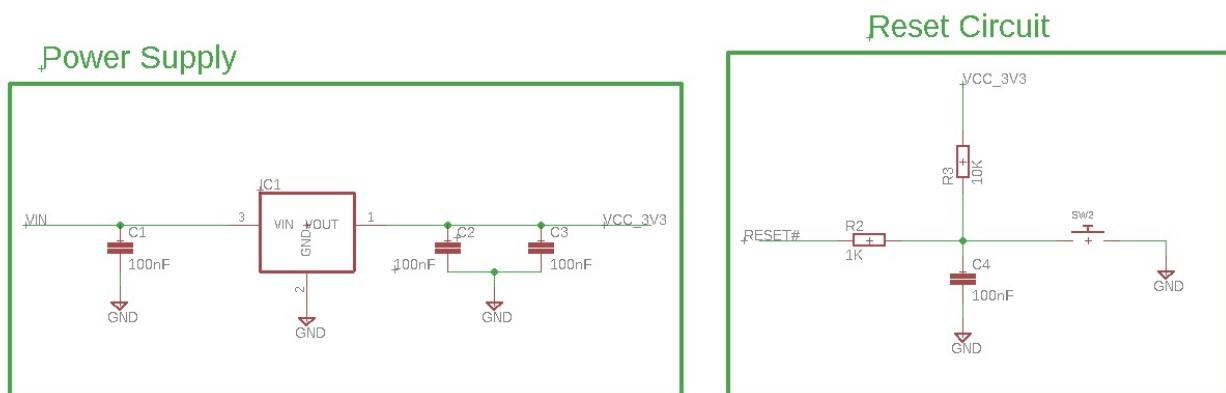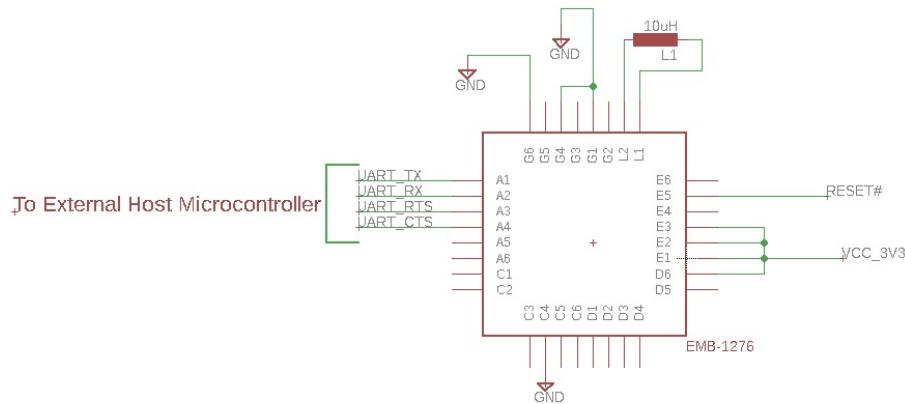

Figure 6. Modem approach typical application circuit.

Notes:

- An EMI filter bead is suggested to filter the Vcc power supply.
- The external supply shall include protection from spikes, short circuits and it requires adequate decoupling.
- Voltage glitches on Vcc supply may cause reset or malfunctioning of the microcontroller.
- Slow voltage ramp on Vcc or RESET# may cause malfunctioning of the microcotroller.
- Do not reset or turn off the power of the module while writing to the flash, otherwise memory corruption may occur.

6 Electrical characteristics

6.1 Absolute Maximum Ratings

Parameter	Value	Unit
Power Supply Voltage	+3.6	Vdc
Voltage on any pin	+3.6	Vdc
Input RF Level	+10	dBm
Storage Temp. Range	-40 to +150	°C

Table 7: Absolute Maximum Ratings.

6.2 Operating Conditions

Parameter	Min	Max	Unit
Power Supply Voltage (Vcc)	+1.8	+3.3	V
Operating Temperature range	-40	+85	°C
Logic Low Input threshold	Vss	Vss+0.6	V
Logic High Input threshold	Vcc-0.6	Vcc	V
Logic Low Output Level	Vss	Vss+0.6	V
Logic High Output Level	Vcc-0.6	Vcc	V

Table 8: Operating conditions.

6.3 Power Consumption

Mode	Typ. value	Unit
TX (+14dBm)	39	mA
RX	12	mA
Idle	2	mA
Sleep	1.9	µA
Backup	900	nA

Table 9: Power consumption.

6.4 RF Characteristic

EMB-LR1276S RF characteristics (Vcc = 3.3V, 25°C, EU Band):

Condition	Min.	Typ.	Max.	Unit
RF Frequency Range	863.00		870.00	MHz
Frequency Tolerance		±10		ppm
Programmable Output Power Range	0		+14	dBm
RF Data Rate LoRa™	0.3		37.5	kbps
Sensitivity (SF7 BW125kHz)		-123		dBm
Sensitivity (SF8 BW125kHz)		-125		dBm
Sensitivity (SF9 BW125kHz)		-128		dBm
Sensitivity (SF10 BW125kHz)		-130		dBm
Sensitivity (SF11 BW125kHz)		-133		dBm
Sensitivity (SF12 BW125kHz)		-136		dBm
RF Input Saturation		+10		dBm

Table 10: RF characteristic.

7 Ordering Information

Part Number	Description
EMB-LR1276S/UL-868	Module with u.FL (pad G5 unused) – 868MHz
EMB-LR1276S/PC-868	Module without u.FL (GSG pads only) – 868MHz

Table 11: Ordering part numbers.

Related products:

Part Number	Description
EMB-LR1276S-Dev Board [4]	Development Board for EMB-LR1276S
EMB-LR1276S-EVK	Evaluation Kit for EMB-LR1276S

Table 12: EMB-1276S related products.

8 References

[1] Microchip, SAMR34/R35 Low Power LoRa Sub-GHz SiP Datasheet

[2] LoRa Alliance, LoRaWAN™ Specification v.1.0.2

[3] Embit, Embit Binary Interface – LoRa specific documentation v.1.0.1

[4] Embit, EMB-LR1276S-Dev Board User Guide rev. 2.1

9 Disclaimer of liability

The user must read carefully all the documentation available before using the product. In particular, care must be taken in order to comply with the regulations (e.g., power limits, duty cycle limits, etc.).

9.1 Handling Precautions

This product is an ESD sensitive device. Handling precautions should be carefully observed.

9.2 Limitations

Every operation involving a modification on the internal components of the module will void the warranty.

9.3 Disclaimer of Liability

The information provided in this and other documents associated to the product might contain technical inaccuracies as well as typing errors. Regulations might also vary in time. Updates to these documents are performed periodically and the information provided in these manuals might change without notice. The user is required to ensure that the documentation is updated and the information contained is valid. Embit reserves the right to change any of the technical/functional specifications as well as to discontinue manufacture or support of any of its products without any written announcement.

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