

**OBJEX**

# ELPM-S3LW

Extreme Low Power Module based on ESP32-S3FN8 and SX1262

v1.1 LW-B



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## 1 | Overview

The ELPM-S3LW is extreme-low power module based on ESP32-S3FN8 and SX1262. Designed for development of IoT devices or generic applications, especially battery-powered devices and energy harvesting applications. The module has a power unit designed to adapt has each specific use, and together with the deep stop mode it is possible to minimize power consumption. ELPM-S3LW is an excellent choice for industrial applications and devices that require high energy efficiency.

### 1.1 | Features

#### Microcontroller

- > Based on ESP32-S3FN8 (32-bit 240MHz)
- > Memory Size: 8MB Flash
- > GPIO: 40 available
- > WiFi - IEEE 802.11 b/g/n-compliant
- > Bluetooth LE: Bluetooth 5, Bluetooth mesh
- > Wi-Fi and Bluetooth share the same antenna
- > Cryptographic hardware acceleration
- > External PSRAM can be installed
- > Interfaces: I<sup>2</sup>C, I<sup>2</sup>S, SPI, UART, USB
- RGB status led (WS2812B)
  - > PIN: GPIO48
- Integrated I2C pullup resistors
  - > SDA: GPIO8
  - > SCL: GPIO9
- > Ceramic antenna (WiFi/BLE)
- > 50 Ohm pin (WiFi/BLE)

#### LoRa

- > Based on SX1262
- > Frequency bands: 862MHz to 928MHz
- > Signal power: 22dBm
- > Transmission distance: 5km
- > Communication interface: SPI
- > Air data rate: 0.3kbps to 62.5kbps
- > Dissipation Power: 1W
- > 50 Ohm U.FL/pad antenna
- > Dedicated LD02 3.3V@300mA
- > Dedicated 3.3V pad
- > Full compatibility with LoRa and LoRaWAN

#### Extreme-low power unit

- > Dedicated LD01 3V3@300mA for ESP32
- > Rising/falling edge detector (1-30nA)
- > Wake and Gate input (1-30nA)
- > RTC RV-3028-C7 (45-100nA)
- > Dedicated RTC power supply pad
- > Battery level circuit (zero leakage current)

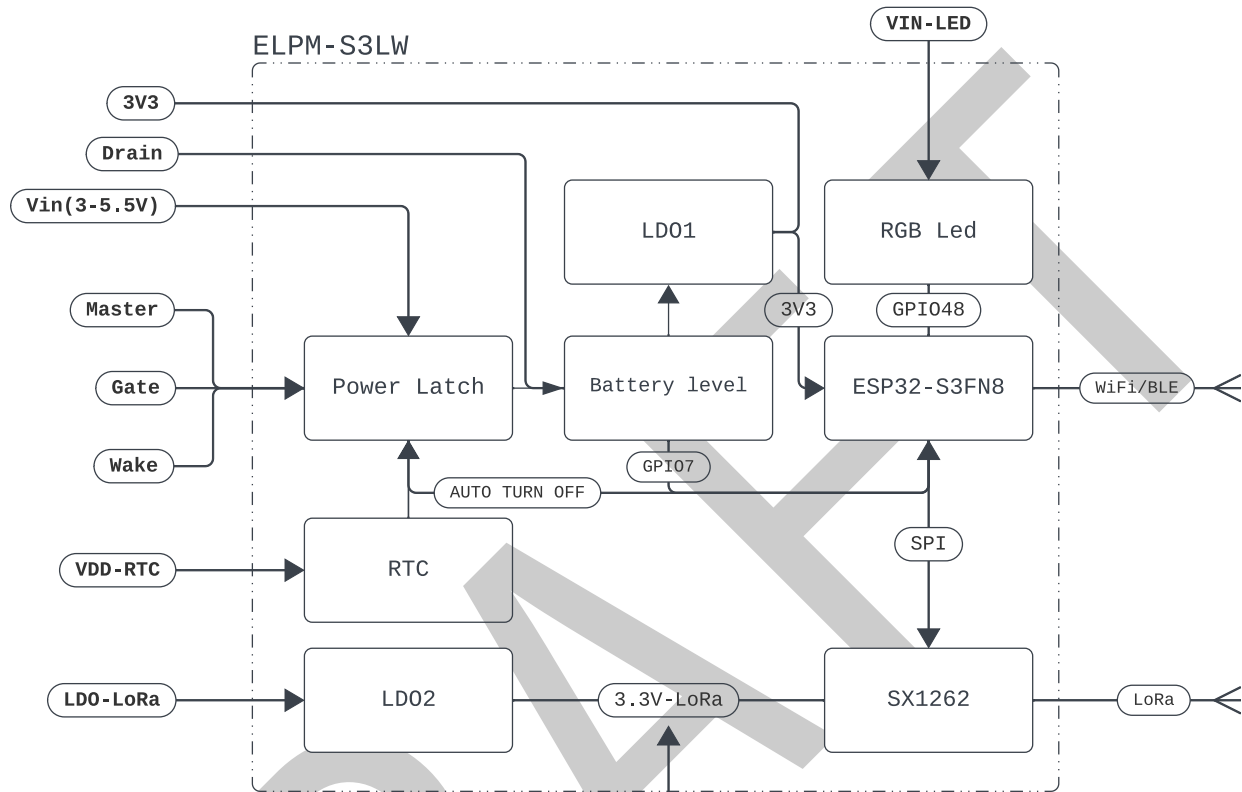
### 1.2 | Deep Stop Mode (Extreme low power)

An effective alternative to the deep sleep mode of the ESP32-S3FN8. Deep Stop mode consists of a power latch and RTC combined with an smart power management system that controls the ESP32-S3FN8, SX1262, and all loads connected to the 3V3 path. By controlling the power supply to all connected loads, it is possible to minimize power consumption, thus increasing the life of the battery. In addition, an external mosfet can be driven (gate pin) to control multiple loads.

### 1.3 | Applications

- Battery-powered nodes
- Smart meters
- Assets Tracking
- Smart cities
- Street Lights
- Supply chain
- Building automation
- Energy harvesting
- Smart Agriculture
- Environmental Sensors

**2 | Block diagram**



**3V3:** Main power path for the ESP32-S3FN8.

**Vin:** Power path handled by the power latch, ideal for a battery.

**Master:** Power latch input: If the status change(0 to 1 || 1 to 0) the P.L. is triggered.

**Gate:** Power latch input: If low, the power latch is activated instantly.

**Wake:** Power latch input: If low, the power latch is triggered with a short startup delay.

**Drain:** Power latch: path between the control block and the input of the primary LDO.

**AUTO TURN OFF:** Input signal to trigger shutdown by power latch.

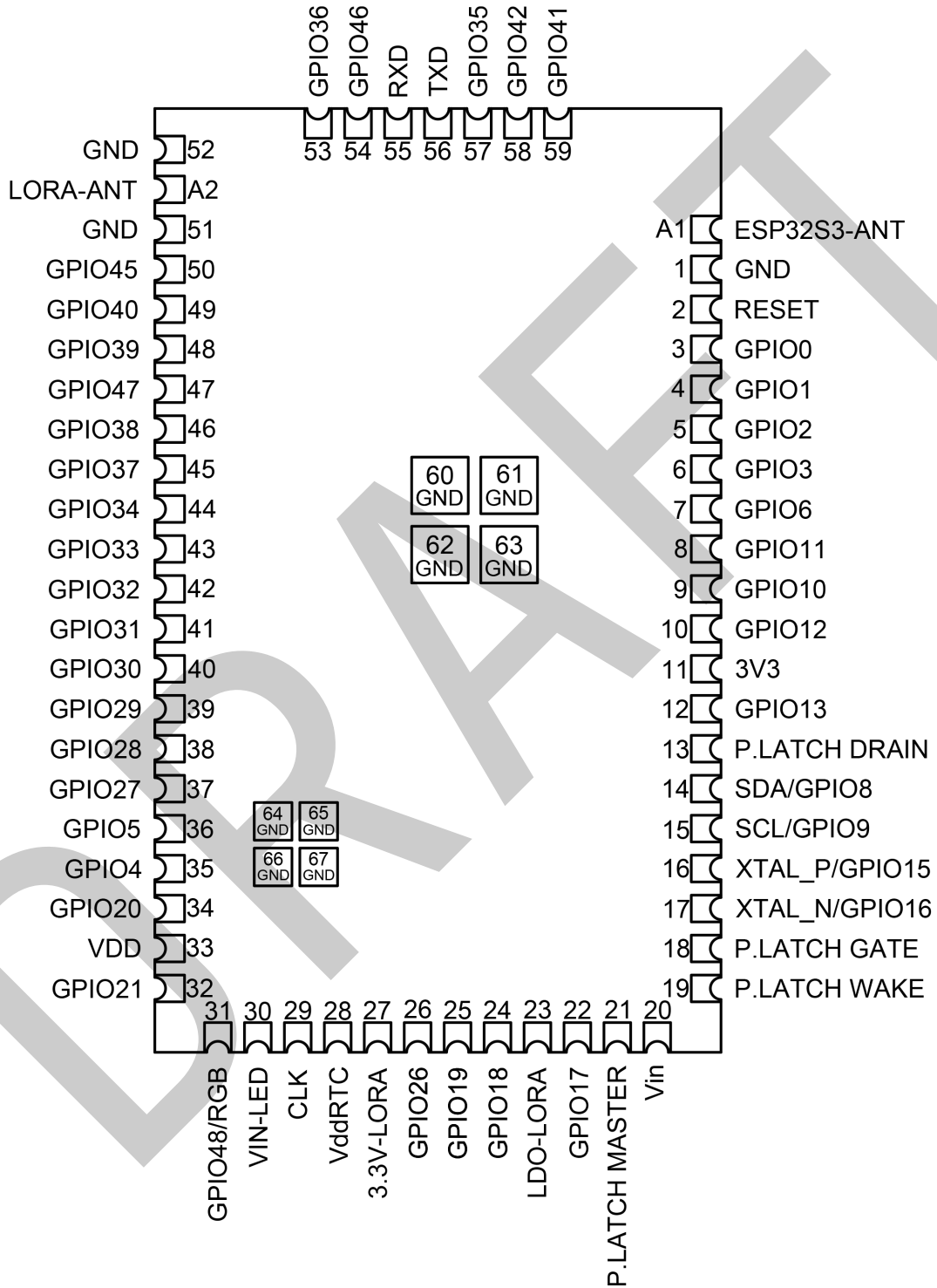
**Vdd-RTC:** Power path reserved for RV-3028-C7.

**LDO-LoRa:** LDO input reserved for SX1262.

**3.3V-LoRa:** Power path reserved for SX1262.

**VIN-LED:** Power path reserved for the RGB LED.

**3 | Pin Definition**



**3.1 | Pin Overview**

The module has 61 pins (castellated holes) and 8 pads (ground only).

No.	Name	Type <sup>a</sup>	Power Domain	Function
A1	ESP32-S3FN8 ANT	RF	-	Antenna interface, impedance 50ohm
A2	SX1262 ANT	RF	-	Antenna interface, impedance 50ohm
1	GND	P	-	Ground
2	RESET	I	3V3-RTC	ESP32-S3FN8 reset pin
3	GPIO0	I/O/T	3V3-RTC	RTC_GPIO00, GPIO0
4	GPIO1	I/O/T	3V3-RTC	RTC_GPIO101, GPIO1, TOUCH1, ADC1_CH0
5	GPIO2	I/O/T	3V3-RTC	RTC_GPIO102, GPIO2, TOUCH2, ADC1_CH1
6	GPIO3	I/O/T	3V3-RTC	RTC_GPIO103, GPIO3, TOUCH3, ADC1_CH2
7	GPIO6	I/O/T	3V3-RTC	RTC_GPIO106, GPIO6, TOUCH6, ADC1_CH5
8	GPIO11	I/O/T	3V3-RTC	RTC_GPIO111, GPIO11, TOUCH11, ADC2_CH0, FSPID
9	GPIO10	I/O/T	3V3-RTC	RTC_GPIO110, GPIO10, TOUCH10, ADC1_CH9, FSPIC0
10	GPIO12	I/O/T	3V3-RTC	RTC_GPIO112, GPIO12, TOUCH12, ADC2_CH1, FSPICLK
11	3V3	P	-	ESP32-S3FN8 Analog power supply
12	GPIO13	I/O/T	3V3-RTC	RTC_GPIO113, GPIO13, TOUCH13, ADC2_CH2, FSPIQ
13	P.LATCH DRAIN	PL	-	Power latch Analog power supply
14	SDA	I/O/T	3V3-RTC	RTC_GPIO108, GPIO8, TOUCH8, ADC1_CH7, SUBSPICS1
15	SCL	I/O/T	3V3-RTC	RTC_GPIO109, GPIO9, TOUCH9, ADC1_CH8, SUBSPIHD
16	XTAL-P	I/O/T	3V3-RTC	RTC_GPIO115, GPIO15, U0RTS, ADC2_CH4
17	XTAL-N	I/O/T	3V3-RTC	RTC_GPIO116, GPIO16, U0CTS, ADC2_CH5
18	P.LATCH GATE	PL	Vin	Power latch input
19	P.LATCH WAKE	PL	Vin	Power latch input
20	Vin	P	-	Power latch Analog power supply
21	P.LATCH MASTER	PL	Vin	Power latch input
22	GPIO17	I/O/T	3V3-RTC	RTC_GPIO117, GPIO17, U1TXD, ADC2_CH6
23	LDO-LORA	P	-	SX1262 Analog power supply
24	GPIO18	I/O/T	3V3-RTC	RTC_GPIO118, GPIO18, U1RXD, ADC2_CH7
25	GPIO19	I/O/T	3V3-RTC	RTC_GPIO119, GPIO19, U1RTS, ADC2_CH8, USB_D-
26	GPIO26	I/O/T	VDD	SPICS1, GPIO26
27	3.3V-LORA	P	-	SX1262 Analog power supply
28	VddRTC	P	-	RTC RV-3028-C7 Analog power supply
29	CLK	O	VddRTC	Clock Output(RV-3028-C7)
30	VIN-LED	P	-	WS2812B Analog power supply
31	GPIO48	I/O/T	3V3-RTC	SPICLK_N_DIFF, GPIO48, SUBSPICLK_N_DIFF
32	GPIO21	I/O/T	3V3-RTC	RTC_GPIO121, GPIO21
33	VDD	P	-	Output power supply: 1.8 V or VDD3P3_RTC
34	GPIO20	I/O/T	3V3-RTC	RTC_GPIO120, GPIO20, ADC2_CH9, CLK_OUT1, USB_D+
35	GPIO4	I/O/T	3V3-RTC	LORA_RST
36	GPIO5	I/O/T	3V3-RTC	LORA_NSS
37	GPIO27	I/O/T	VDD	SPIHD, GPIO27
38	GPIO28	I/O/T	VDD	SPIWP, GPIO28
39	GPIO29	I/O/T	VDD	SPICS0, GPIO29
40	GPIO30	I/O/T	VDD	SPICLK, GPIO30
41	GPIO31	I/O/T	VDD	SPIQ, GPIO31
42	GPIO32	I/O/T	VDD	SPID, GPIO32
43	GPIO33	I/O/T	3V3-CPU/VDD	SPII04, GPIO33, FSPID, SUBSPIHD
44	GPIO34	I/O/T	3V3-CPU/VDD	SPII05, GPIO34, FSPIC0, SUBSPICS0
45	GPIO37	I/O/T	3V3-CPU/VDD	SPIDQS, GPIO37, FSPIQ, SUBSPIQ
46	GPIO38	I/O/T	3V3-RTC	GPIO38, FSPIWP, SUBSPIWP
47	GPIO47	I/O/T	VDD	LORA_DIO1, SPICLK_P_DIFF, GPIO47
48	GPIO39	I/O/T	3V3-CPU	MTCK, GPIO39, CLK_OUT3, SUBSPICS1
49	GPIO40	I/O/T	3V3-CPU	MTDO, GPIO40, CLK_OUT2
50	GPIO45	I/O/T	3V3-CPU	LORA_SCK
51	GND	P	-	Ground
52	GND	P	-	Ground
53	GPIO36	I/O/T	3V3-CPU/VDD	LORA_MOSI, SPII07, GPIO36, FSPICLK, SUBSPICLK
54	GPIO46	I/O/T	3V3-CPU	LORA_BUSY, GPIO46
55	RXD	I/O/T	3V3-CPU	GPIO44, CLK_OUT2
56	TXD	I/O/T	3V3-CPU	GPIO43, CLK_OUT1

No.	Name	Type <sup>a</sup>	Power Domain	Function
57	GPI035	I/O/T	3V3-CPU/VDD	<b>LORA_MISO</b> , SPII06, GPI035, FSPID, SUBSPID
58	GPI042	I/O/T	3V3-CPU	<b>MTMS</b> , GPI042
59	GPI041	I/O/T	3V3-CPU	<b>MTDI</b> , GPI041, CLK_OUT1
60	GND	P	-	Ground
61	GND	P	-	Ground
62	GND	P	-	Ground
63	GND	P	-	Ground
64	GND	P	-	Ground
65	GND	P	-	Ground
66	GND	P	-	Ground
67	GND	P	-	Ground

<sup>a</sup> P: power supply; RF: radio frequency; PL: power latch; I: input; O: output; T: high impedance. Pin functions in **bold** font are the default pin functions.

### 3.2 | Strapping pins

At each startup or reset, a module requires some initial configuration parameters, such as in which boot mode to load the module, voltage of flash memory, etc. These parameters are passed over via the strapping pins. After reset, the strapping pins operate as regular IO pins. The parameters controlled by the given strapping pins at module reset are as follows:

- Chip boot mode - GPI00 and GPI046
- VDD\_SPI voltage - GPI045
- ROM messages printing - GPI046
- JTAG signal source - GPI03

GPI00, GPI045, and GPI046 are connected to the chip's internal weak pull-up/pull-down resistors at chip reset. These resistors determine the default bit values of the strapping pins. Also, these resistors determine the bit values if the strapping pins are connected to an external high-impedance circuit.

For more details please read the official documentation of Espressif ([ESP32-S3FN8](#)).

### 3.3 | Pins used

Some GPIOs of the ESP32-S3FN8 are used to handle some module features.

- SDA - GPI08
- SCL - GPI09
- Auto turn off - GPI014
- Battery level - GPI07

## 4 | Electrical characteristics

### 4.1 | Absolute maximum ratings

To ensure the proper operation of the ELPM-S3LW, it is recommended that the ranges of the Operating Conditions be observed.

Symbol	Parameter	Min	Max	Unit
3V3	Power supply voltage	3.0	3.6	V
V <sub>in</sub>	Power latch or Battery input	3.0	5.5	V
LDO-LORA	LD02 input	3.0	5.5	V
3.3V-LORA	3.3V power path for LoRa ICs	3.0	3.5	V
V <sub>dd</sub> RTC	Power path for RTC(RV-3028-C7)	3.0	3.3	V

### 4.2 | Maximum ESD ratings

Parameter	Min	Max	Unit
ESD immunity	±2	±12*	kV

\*Maximum protection guaranteed only on the 3.3V.

### 4.3 | Operating temperature range

Parameter	Min	Max	Unit
Operating temperature	-40	+85	°C

### 4.4 | Power consumption

Work mode	Description	Temp	V <sub>in</sub>	Min	Typ	Unit
Deep Stop (RTC disabled)	Master, gate/Forceon, wake input triggering the power latch. RTC not powered.	+20°C to +30°C	3.3V	<1	5	nA
Deep Stop with RTC	RTC powered. Multiple interrupt sources.	+20°C to +30°C	3.3V	40	80	nA
Deep sleep	Default deep sleep mode of ESP32-S3.	+20°C to +30°C	3.3V	6	10	µA

### 4.5 | Startup time

The power latch is capable of booting the whole system in a few milliseconds ensuring high reactivity. It is possible to reduce the startup time of the ESP32-S3 boot by tuning the boot options.

Interrupt mode	Description	typ	Unit
Master Platch	Change of input status.	30	ms
RTC Wake	Programmed awakening.	80	ms
Gate/FORCEON	Gate input to GND.	20	ms
Wake	Wake input to GND.	500	ms

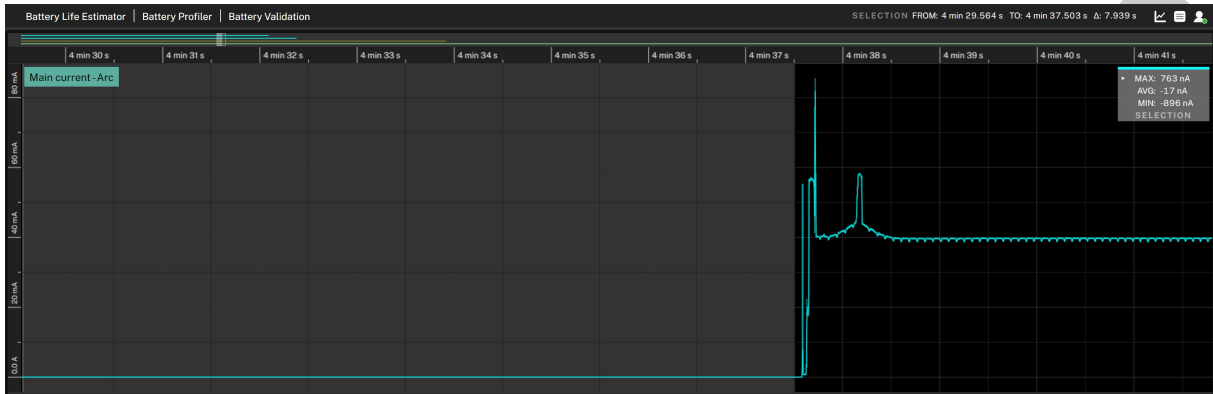
  

ESP32-S3FN8	typ	Unit
Default startup time	105	ms

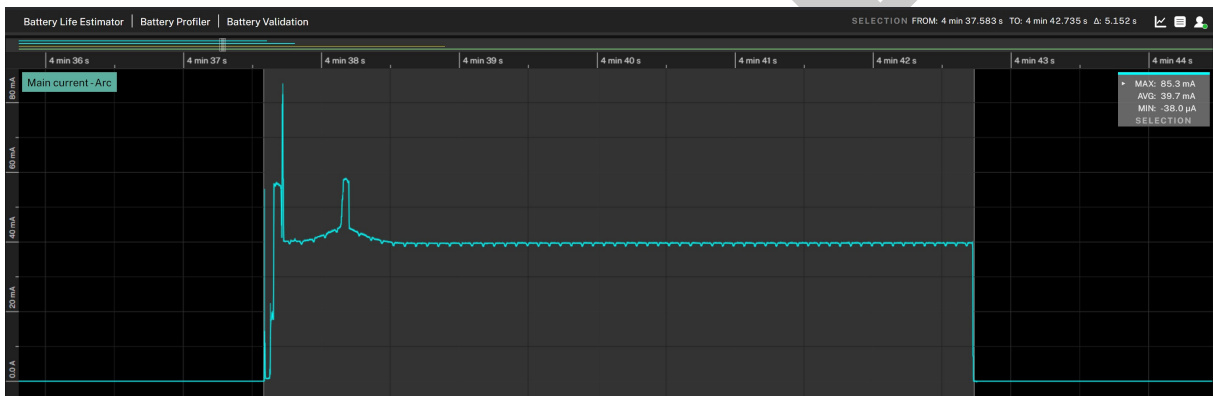


## 5 | Deep Stop performance

### 5.1 | Master/Wake mode

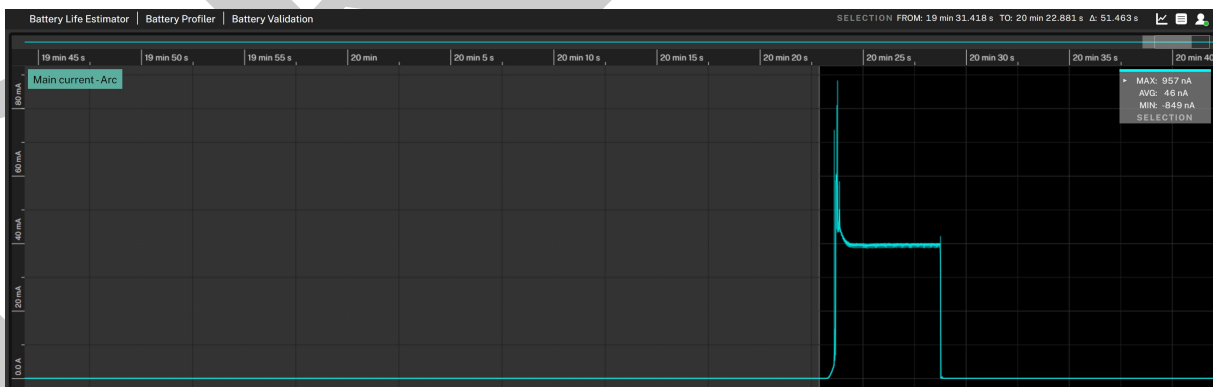


**Figure 5.1:** Deep stop

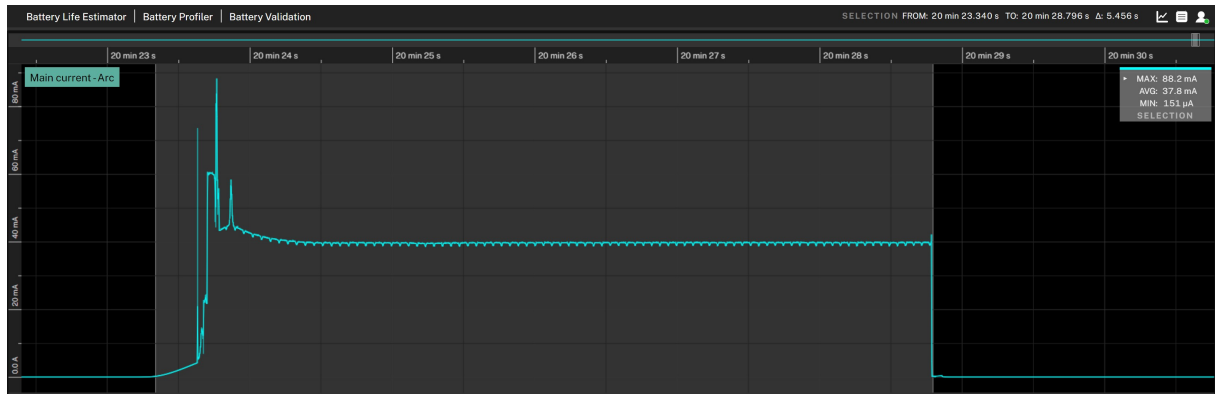


**Figure 5.2:** System startup

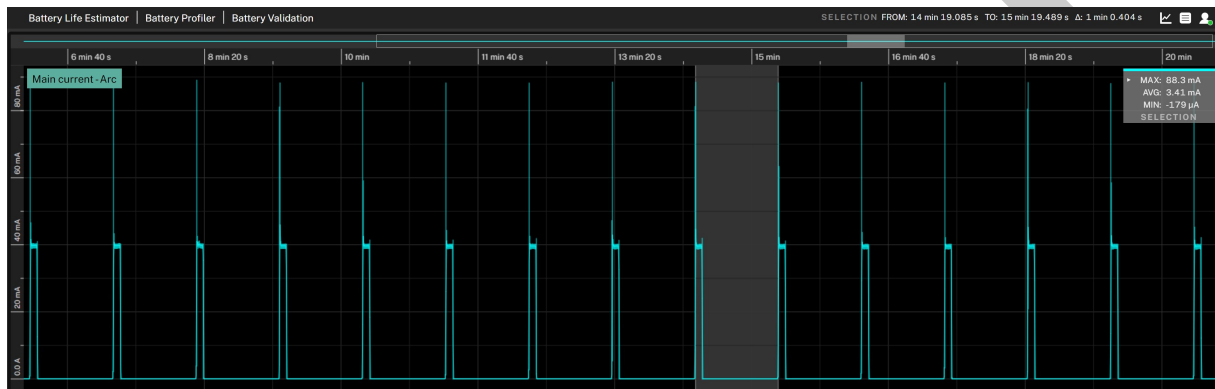
### 5.2 | RTC mode



**Figure 5.3:** Deep stop



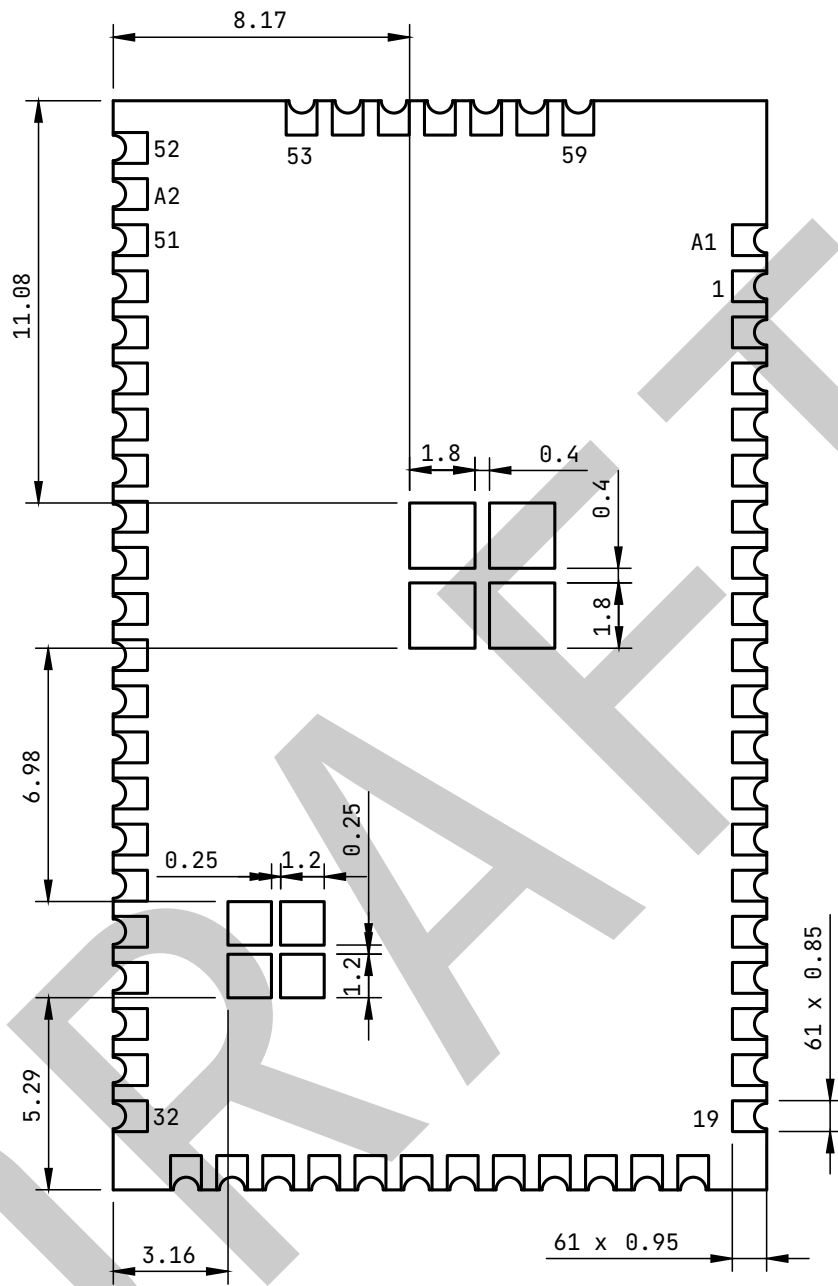
**Figure 5.4:** System startup



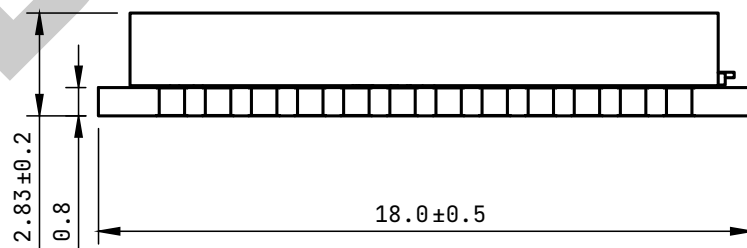
**Figure 5.5:** Example: Wake-up every minute



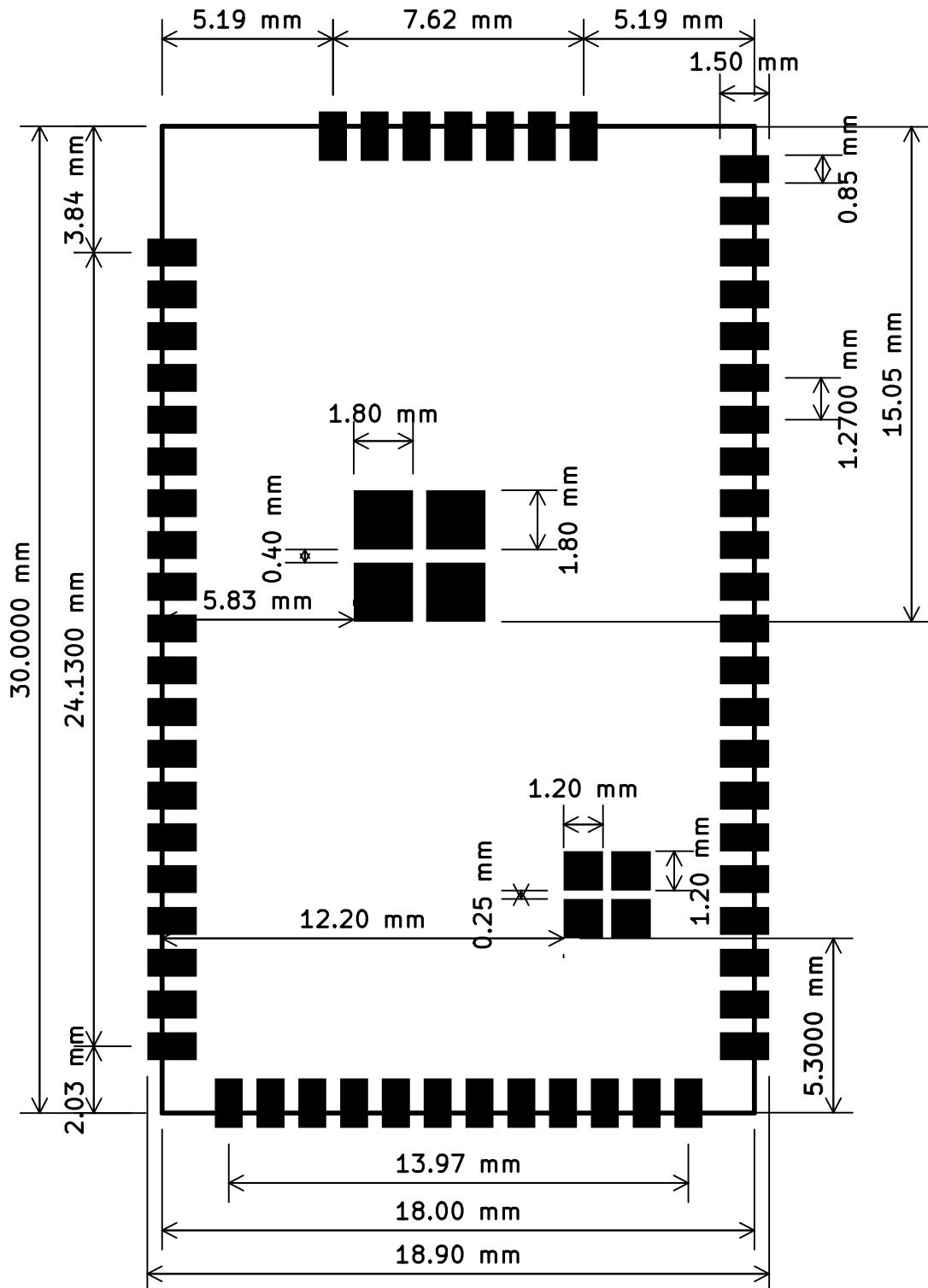
6.2 | Bottom view



6.3 | Side view



6.4 | Recommended PCB footprint



**7 | Related documentation**

- [ESP32-S3 Series](#) - Microcontroller
- [SX1262](#) - LoRa IC
- [RV-3028-C7](#) - Extreme low power ext. RTC

**8 | Certification**

Pending release of the ELPM-S3LW version for mass production.

**9 | Revision history**

Revision	Date	Description
v1.1	04/18/2024	Power consumption graphs, general bugfix (document still being finalized - draft)
v1.0	03/05/2024	Updated the value frequency bands 862MHz to 928MHz
v1.0	02/26/2024	Preliminary version for partners

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