Tag Piccolino v2r5
Tiny Tag powered by coin battery

Features

- Real-Time Location with UWB and TDoA Technique
- Movement Detection / Sensor Data
- Identification, unique MAC address
- Decawave UWB Radio, 3-7GHz
- Wireless Tag Configuration via RTLS Studio
- Coin CR2450 600mAh (Optionally CR2477 950mA)
- User LED and User Button

UWB **UWB**

Movement Detection

White labelling possible

Optional

Source code available

HW layout available

Tag is an active mobile locator. Its position is reported within selected refresh rate. Tracked objects need to be equipped with this device.

Tag is powered from a coin battery and configurable through RTLS Manager web interface. It is equipped with UWB radio module with omnidirectional ceramic antenna. The Tag Piccolino also features an accelerometer for movement detection to prolong the battery lifetime.

Position Update | Battery Lifetime

10s	years
5s	
2s	
1s	
100ms	days
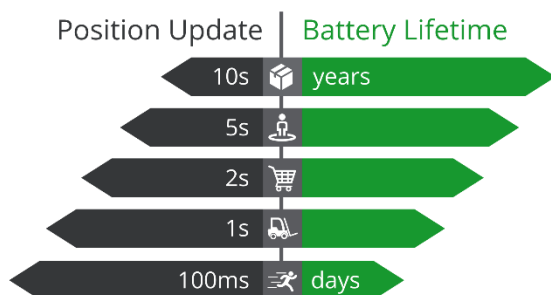
Dimensions (without enclosure)	29 x 37 x 11 mm
Weight	26 g
Refresh Rate	50ms – 60s
Battery Lifetime*	10s – 5 years
	1 s – 1 year
	500ms – 248 days
	100ms – 53 days
CR2450 Battery Capacity	600mAh
UWB Range	15-50m
Temperature Range	0 - 50°C
For Indoor Use Only ⌂	

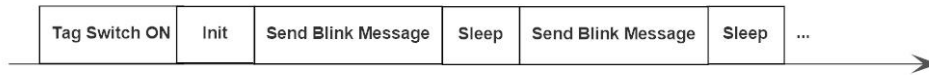*depends on RF Profile settings, can be significantly prolonged with the movement detection feature

Content

1 Tag Behavior

1) Tag is initialized after it is turned on by holding the button for two seconds.

2) Then it sends location message (blink message) periodically with given refresh rate.

Tag Switch ON	Init	Send Blink Message	Sleep	Send Blink Message	Sleep	...

This message is received by set of Anchors and it is forwarded to RTLS Studio via Ethernet of WiFi backhaul, where position is calculated. The blink message can be optionally equipped with sensor data. All the data is further disseminated trough the API.

1.1 Button Functionality

The button functionality for Tag Piccolino is described in following video tutorial.

1) **Turning the Tag on and off**
Tag is turned ON or OFF by holding the ON/OFF button for 2 seconds. If the battery is low the tag enters sleep mode. (4 fast LED blinks, with period of 200 milliseconds, signalize low battery status).

2s

Holding the button   Releasing the button

2) **Configuring the Tag**
The Tag tries to receive wireless configuration from RTLS Studio, only if the button is being continuously held for 4 seconds on startup. 3 LED blinks with period of one second signalize successfully received configuration message and reconfiguration. If the battery is low for configuration, then 4 fast LED blinks, with period of 200 milliseconds are going to blink. If configuration was not received, then LED won't signalize anything.

4s

Turning on

Holding the button   Releasing the button

3) **Resetting the Tag**
Piccolino Tag can be RESET to the default configuration by three consecutive button pushes. Each push has to be around 1 second long. Time difference between the consecutive pushes has to be around 1 second as well.

1s

1s

Hold   Release

1.2 Basic Blink Messages

Blink messages are briefly described in table below.

| Blink Message	Frequency	Payload
Standard blink	Set by refresh rate parameter	Blink sequence number and MAC address only
Battery blink	Every 15th blink	STD blink content + battery level
Info blink	After power-up three info blinks are sent. Then every 15th battery blink	Battery blink content + info about: Tag Type, HW & FW versions, user setting of tag parameters and mounted sensors
Extended blink	Set by refresh rate parameter	Blink with sensors data

Table 1:Blink Types

For more details about Tag messaging please read *AN11, AN12 Custom Tag Integration*.

1.3 Motion detection and Sleep modes

Motion detection utilizes the accelerometer's data to detect, whether the Tag is moving or not. This information gives the tag possibility to go into sleep mode once it is stationary. This brings two benefits: it prolongs the battery lifetime and decreases communication workload over the channel.

Tag has four sleep mode options

- Disabled
- Delayed sleep
- Immediate sleep
- Keep alive
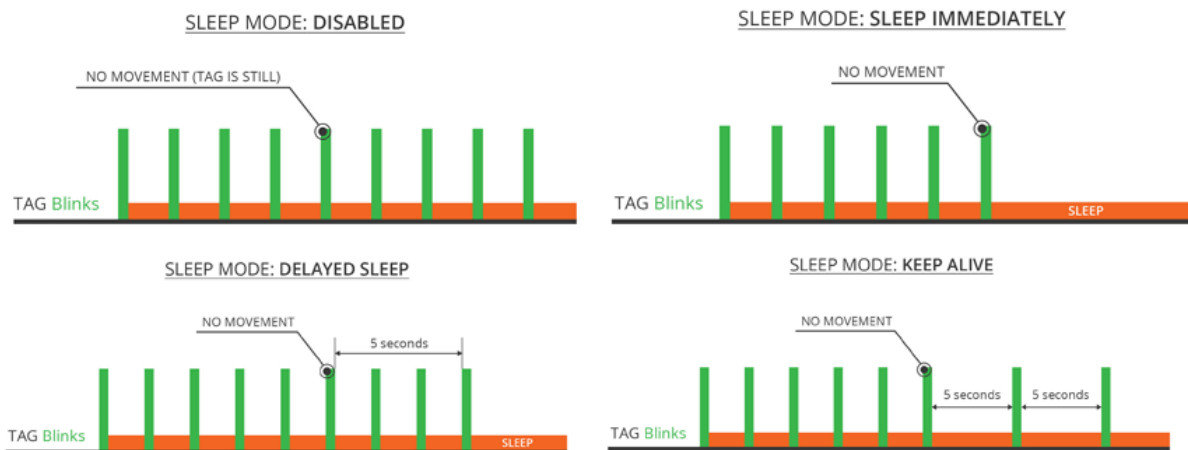
- ▪ **Disabled**
  Tag send blink message regularly and movement detection is inactive.
- ▪ **Delayed sleep (5s)**
  Once no movement is detected, tag remains sending blinks for a 5 second period and then go into sleep

mode. This mode can be useful in scenarios when accurate position is required at the spot where tag was stopped.

- ▪ **Immediate sleep**
  Tag is put into deep sleep immediately after no motion event is detected.
- ▪ **Keep alive (5s)**
  Tag is put into sleep immediately after no motion event is raised, still it sends blink every 5 seconds. After the blink is sent, the tag is put back into deep sleep. This feature is useful for static tag tracking. *This mode is available from FW 3.118.*

2 Channel Utilization

The Tag sends blinks periodically plus a random offset through a so-called ALOHA channel access method. However, once more Tags are in the same radio range their positions are estimated by the same set of Anchors and if they transmit at the same time, collision occurs. In this case, positions cannot be calculated. Therefore, one needs to think about the channel utilization for a given application. The table below shows the total Tag number for a recommended RF profile and refresh rate. Please do not use other modes for Tags.

Note: Please keep in mind that the number of Tags calculated below applies for the multiple Tags in the same radio range (location cell). There is no limitation for total number of Tags running across the whole system.

Tag RF profile / Tag Refresh Rate	Blink TX Time [ms]	10s (0.1 Hz)	1s (1 Hz)	0.5s (2 Hz)	100ms (10Hz)
RF4	0.432	4166 Tags	416 Tags	208 Tags	41 Tags
RF5	0.175	10285 Tags	1028 Tags	514 Tags	102 Tags

Table 2 Channel Utilization - Number of Tags in one location cell without collisions for given RF profile

Calculation example: Probability of collision depends on the blink length. ALOHA access method has 18% limit where there is high probability of transmissions without collisions. Let us calculate an example where Tags have the same refresh rate 1s and RF5 profile is used. Blink time for this profile is 0.175ms. Therefore, the number of Tags within the same physical vicinity without collisions is 1028 (1000ms/0.175ms*0.18).

Once the blink message is equipped with sensor data, the utilization of the radio channel will be higher with the same RF profile and Refresh rate. The following table shows the maximum Tag number for a given RF profile and refresh rate, if the quaternions are sent.

Tag RF profile / Tag Refresh Rate	Blink TX Time [ms]	10s (0.1 Hz)	1s (1 Hz)	0.5s (2 Hz)	100ms (10Hz)
RF4	0.468	3813 Tags	381 Tags	190 Tags	38 Tags
RF5	0.18	9917 Tags	991 Tags	495 Tags	99 Tags

Table 3 Channel Utilization - Number of Tags with sensor data in one location cell without collisions for given RF profile

Note: Sewio provides channel utilization spreadsheet for calculating customer scenario.

3 RF Profiles

Tag can operate in two RF profiles RF4 and RF5. Originally there were six RF Profiles, but they are deprecated, please do not use them anymore. RF profile selection is a tradeoff between energy consumption, channel utilization and signal robustness. Energy consumption and channel utilization can be compared with online calculators.

Tags and Anchors within the RTLS must be set to the same RF profile for blinks, otherwise the devices will not be able to communicate.

Here is a brief RF Profiles comparison:

Order	Channel Utilization	Energy Consumption	Signal Robustness and Range
Best	RF5	RF5	RF4
Worst	RF4	RF4	RF5

Table 4 RF Profiles Comparison

3.1 RF Profile Selection

RTLS TDoA requires wireless synchronization of Anchors which is carried over the UWB channel. Therefore, the Anchor spends a small portion of time in synchronization period and rest of the time in a blink period. If both periods are selected to be on the same channel, the best practice is to set the sync period and blink period to non-interfering RF Profiles to avoid collisions. Please note that the blink period must be set equally between Tags and Anchors at all times.

Recommended profile allocation for the same channel: Sync period CH 5, RF0 and Blink period CH 5, RF4.

RF profiles are set through RTLS Studio -> RTLS Manager -> Tab Anchors Summary and Tab Tags Summary.

In the table below are listed profiles which may be used without interference.

RF profile	RF0	RF1	RF2	RF3	RF4	RF5
RF0	✖	✖	✖	✔	✔	✔
RF1	✖	✖	✖	✔	✔	✔
RF2	✖	✖	✖	✔	✔	✔
RF3	✔	✔	✔	✖	✖	✖
RF4	✔	✔	✔	✖	✖	✖
RF5	✔	✔	✔	✖	✖	✖
✔	Without Interferences					
✖	Interferences occurs					

Table 5 RF profiles interferences

4 Battery Lifetime Estimation

The table below shows battery estimation for a given RF profile and refresh rate.

Tag RF profile / Tag Refresh Rate	10s (0.1 Hz)	1s (1 Hz)	0.5s (2 Hz)	100ms (10Hz)
RF4	3.9 years	0.9 year	186 days	40 days
RF5	4.1 years	1 year	215 days	47 days

Table 6 Battery Lifetime for 600mAh Capacity – estimated as 8 hours of continuous transmissions per day. Can be further prolonged with the movement detection feature.

Note: *Sewio provides spreadsheet to calculate battery lifetime for given application.*

4.1 Power Consumption

During the operation, the device goes through several states with different power consumption. These states states are listed in Table 7. Current consumption in all states was measured in default Tag configuration.

State	Current consumption [mA]	Duration [ms]	Description
TX state	140	2.3	Standard blink sent
RX state	150	Dependent on user setting	Wait for wireless config message
UWB sleep, MCU active	7.36	0.078	Overhead
UWB idle, MCU active	23.6	5.4	Wait for XTAL stabilization
UWB sleep, MCU sleep	0.087	Dependent on Refresh rate	Sleep

Table 7 Power consumption in various states

5 Tag Default Settings

Tag can get back default settings* after the device reset procedure.

Parameter	FW 3.115	FW 3.118	FW 3.118 (from 1.10.2018)
Refresh Rate	100 ms	1000 ms	1000 ms
Channel	5	5	5
RF Profile	RF3	RF3	RF4
Sleep mode (previously Acc Mode)	Immediate sleep	Immediate sleep	Immediate sleep
Sleep threshold	Low (63 mg)	Low (63 mg)	Low (63 mg)
Random Deviation	Enable	Enable	Enable
Periodical RX	N/A	N/A	N/A
RX Duration	N/A	N/A	N/A
Sensors	N/A	Disable	Disable
Accelerometer Dynamic Range	N/A	±2 g	±2 g
Gyroscope Dynamic Range	N/A	N/A	N/A
Barometer mode	N/A	Disable	Disable

Table 8 Tag Default Configuration

Note: *Default settings can differ if customer requires custom configuration for its project. It could be also changed within firmware revisions, please check partner portal for the current info.*

6 Wireless Configuration

Please perform the wireless configuration of the Piccolino Tag only with a new CR battery.

Configuration is transferred to the Tag via the UWB link from a selected Anchor. During the configuration, the Anchor is not available for location purposes.

Please watch our Tag Configuration *Tutorial and* Tag Features *Tutorial videos.*

6.1 RTLS Studio version 1.4.0 and higher

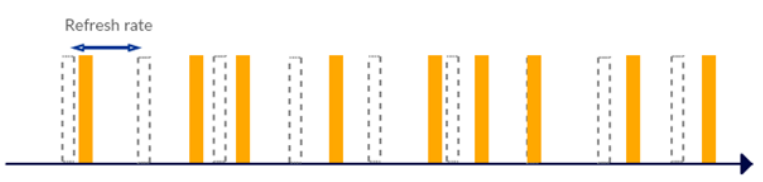1) RTLS Studio -> RTLS Manager -> Tag Summary, click on Advanced Setting to access Sensor Settings
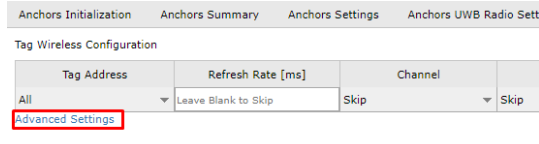
2) Please select the Tag address, otherwise set it to "All". Then set the parameters that you wish to change. You will need to select actual Tag firmware and also the Anchor address that will broadcast new configuration to the Tag.

The following parameters are available:

Parameter	Value	Description
Refresh rate [ms]	10 – 60000 [ms]	The Tag's refresh rate
Channel	1,2,3,4,5,7	The Blink radio channel
RF Profile	RF0-RF5	The RF Profile setting
Power	Min-Max	Tag's transmit power
Sleep mode (previously Acc Mode)	Keep alive (5s) Immediate sleep Delayed sleep Disable	Sleep mode for movement detection feature.
Sleep threshold	Low Medium High Custom <4;8001> [mg]	Threshold of acceleration for wakeup the tag from sleep.
FW	FW Version	Select Tag's firmware version
Anchor	MAC Address	Select which Anchor will send the configuration wirelessly

The following advanced parameters are available:

Parameter	Value	Description
Random Deviation	1 – enabled – Tag TX in defined refresh rate + random offset 0 – disabled – Tag TX in defined refresh rate	Option 1 Random deviation enabled – Tag blinks randomly within regular refresh rate. Always use this option as it is required for Aloha. Option 0 Random deviation disabled – Tag blinks in regularly in given refresh rate. This option is for testing purposes only.

		Refresh rate
Periodical RX	Value [ms] <100, 129 000 000>	N/A
RX Duration	Value [ms] <50, 60 000>	N/A
Sensors	Accelerometer Disable	Raw data from each sensor can be sent within extended blink message.
Accelerometer Dynamic Range	± 2 g ± 4 g ± 8 g ± 16 g	Dynamic range of accelerometer data output.
Gyroscope Dynamic Range	± 250 dps ± 500 dps ± 1000 dps ± 2000 dps	N/A
Barometer mode	Low power Normal mode High precision Disable	N/A

3) Press the Start/Stop (Start Update) button. The selected Anchor will start sending the new configuration.

Sleep Mode	Sleep threshold	FW	Status	Anchor	Action
o	Skip	Tags with FW 3.118 and ne		d880396219e0 (Anchor #:	Start Update

4) Tag receive configuration messages after the power up, therefore turn off and turn on the Tag.

Note: If Periodical RX is enabled you may wait until the tag automatically switches to the RX state and receives the new settings.

5) When the new settings are being sent, the positioning will be disabled. After the update is done, stop the transmission by clicking the Start/Stop button again.

6) New settings should appear within Online Tags table immediately.

7 Tag Dimensions
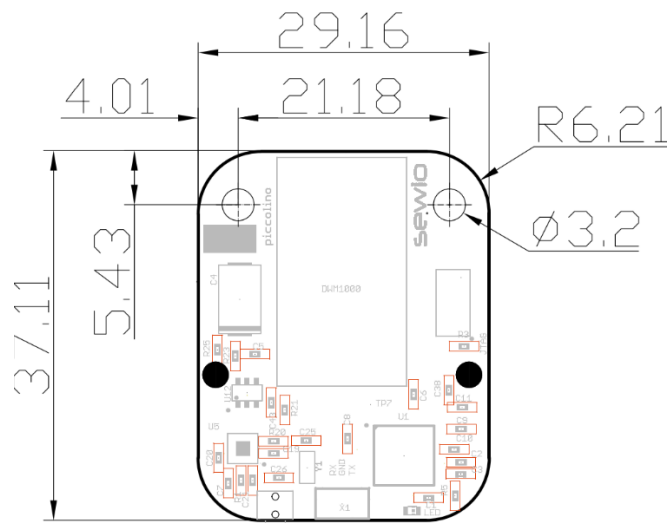
8 Battery Selection

Please select proper battery carefully. Not all CR2450 battery available are suited for Tag Piccolino. According to our tests we recommend using Tecxus, Energizer or Panasonic coin battery listed in table below.

Other vendors such as RENATA or VARTA are not recommended to be used with Tag Piccolino.

CR2450 600mAh

Manufacturer	Part Number	Battery Type	Datasheet	Compliance with Tag Piccolino
TECXUS	23688	CR2450	link	Approved*
ENERGIZER	CR2450 BULK	CR2450	link	Samples Measured Passed**
PANASONIC	CR2450	CR2450	N/A	Samples Measured Passed**
VARTA (do not use)	6450 101	CR2450	N/A	Sample Measured Failed***

CR2477 1000mAh (optional - requires different battery holder)

Manufacturer	Part Number	Battery Type	Datasheet	Compliance with Tag Piccolino
PANASONIC	BAT-CR2477/P	CR2477	link	Approved*
RENATA (do not use)	CR2477N	CR2477	N/A	Sample Measured Failed***

*Results approved by a long test at different customers
**Results measured at Sewio test lab
***Measured battery samples were too weak or behave unstable. Please do NOT use these batteries with Tag Piccolino.

9 Enclosures

Piccolino tag is delivered with a holder for the CR2450 battery. Optionally, it can be equipped with the CR2477 battery holder.

	Piccolino with CR2450 Standard	Piccolino with CR2477 Optional (per request)
Battery	CR2450	CR2477
Piccolino with appropriate holder		
Capacity	650mAh	950mAh
Height (without Enclosure)	10.6mm	14mm
Weight (Tag+Enclosure+Battery)	26g	28g
Suitable OKW Enclosure	B1606207 (recess, orange) B1606217 (recess, black) B1606107 (orange) B1606117 (black) Enclosures requiring foam filling to fix the tag with CR2450.	B1606107 (orange) B1606117 (black)
Sewio 3D Enclosure Models for print	Available	N/A

CR2477
CR2450

CR2450

B1606107 ⓘ 🛒
BODY-CASE,
without recess

ASA (UL 94 HB)
traffic white RAL 9016
55x46x17mm
IP 67, IP 65

B1606117 ⓘ 🛒
BODY-CASE,
without recess

ASA (UL 94 HB)
traffic white RAL 9016
55x46x17mm
IP 67, IP 65

B1606207 ⓘ 🛒
BODY-CASE, with
recess

ASA (UL 94 HB)
traffic white RAL 9016
55x46x17mm
IP 67, IP 65

B1606217 ⓘ 🛒
BODY-CASE, with
recess

ASA (UL 94 HB)
traffic white RAL 9016
55x46x17mm
IP 67, IP 65

Accessory "carrying"

B1706001 ⓘ 🛒
Fastening kit

ASA (UL 94 HB)
traffic white RAL 9016

B1706202 ⓘ 🛒
Wrist strap, 18
mm

Silicone
black

B1706203 ⓘ 🛒
Spring bar tool

Stainless steel

B9100043 ⓘ 🛒
Hand strap, woven

black
200mm