TECHNICAL INFORMATION MANUAL

Revision 4 – 03 March 2021

A927Z

UHF Semi-Passive Logger Tag

easy2log

CAENRFID

Visit A927Z web page, you will find the latest revision of data sheets, manuals, certifications, technical drawings, software and firmware. All you need to start using your tag in a few clicks!

Scope of Manual

The goal of this manual is to provide the basic information to work with the A927Z UHF Semi-Passive Logger Tag.

Change Document Record

Date	Revision	Changes	Pages
13 Aug 10	01	Initial release.	-
25 Mar 13	02	Added MM bit in the § *Control* register	24
		Removed information about *A927ZH Humidity logger UHF semi-passive tag* and *A927Z5Y*	6, 7, 8, 9, 33
		Added information on *CAEN RFID Development Kit* in the § *Ordering Options* table	7
		Changed *Fig. 1.2: easy2log© A927ZET UHF Semi-Passive Logger Tag with external probe*	6
		Modified § *Introduction* paragraph	6
		Modified § *Tab. 4.1: A927Z Technical Specifications*	29
		Added warning	29
07 Jul 17	03	Modified § *CE Compliance* and *A927Z CE Declaration of Conformity* paragraphs	33, 34
03 Mar 21	04	Modified § *CE Compliance* and *A927Z CE Declaration of Conformity* paragraphs	33, 34

Symbols, abbreviated terms and notation

DR	Divide ratio
FT	Frequency tolerance
TRcal	Tag-to-Interrogator calibration symbol
XXXXb	Binary notation
XXXXh	Hexadecimal notation
Tari	Reference time interval for a data-0 in Interrogator-to-Tag signaling. The mnemonic “Tari” derives from the ISO/IEC 18000-6 (part A) specification, in which Tari is an abbreviation for Type A Reference Interval.
CRC	Cyclic Redundancy Check
RFID	Radio-Frequency IDentification
RFU	Reserved for Future Use
Word	16 bit

Reference Document

[RD1] EPCglobal: EPC Radio-Frequency Identity Protocols Class-1 Generation-2 UHF RFID Protocol for Communications at 860 MHz – 960 MHz, Version 2.0.1 (April, 2015).

[RD2] A927Z EN12830 Test Report – 1 March 2010

[RD3] TesLab s.r.l. - Environmental Test Report - A927Z - Temperature logger UHF semi-passive tag -ref. TesLab 09B204A – 10 December 2009

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Disposal of the product

Do not dispose the product in municipal or household waste. Please check your local regulations for disposal/recycle of electronic products.

Index

List of Figures

List of Tables

1 INTRODUCTION

Product Description

CAEN RFID easy2log© A927Z is a low cost, ruggedized, semipassive UHF logger tag that allows to monitor temperature sensitive products like perishable foods and pharmaceuticals, during transportation and storage. The combination of the high resolution sensor, the large memory size and the standard RFID interface permits to realize effective track and trace solutions for the cold-chain.

The A927Z can be used with standard UHF RFID readers available on the market without requiring any additional equipment thanks to its compatibility with the EPCGlobal C1G2 and ISO18000-6C standards.

The tag can be configured to store temperature samples in intervals from 8 second to 18 hours in the internal memory that can contain up to 8,000 samples. The user can define alarms for high and low temperature thresholds for an accurate control of the temperature excursions.

The rugged enclosure of this logger make it the perfect choice for the cold-chain monitoring in harsh environment or in presence of strong vibration.

The A927Z RFID logger can be used for multiple shipments thanks to the long battery life and the reset function thus allowing to reduce the total cost of the solution and anticipate the ROI.

Fig. 1.1: easy2log© A927Z UHF Semi-Passive Logger Tag

In addition to the A927Z, **the easy2log© family** also includes A927ZET tag. In the Mod. A927ZET an additional sensor is placed on an external probe so it is possible to measure temperature even inside a shielded box where the RFID field cannot get through.

- Mod. A927ZET, a semipassive tag of the easy2log© Family with external probe for double temperature measurement in a single device (Fig. 1.2).

Fig. 1.2: easy2log© A927ZET UHF Semi-Passive Logger Tag with external probe

The A927Z tag is included in all our RFID Reader Development Kits.

RFID Reader Development Kits allow to get acquainted with reader performances, from simple testing of RFID features to full implementation of middleware and custom applications.

These Kits include Reader, Antenna, Tags, Software, Documentation and Cabling. Everything you need to get started on UHF RFID.

Ordering Options

	Code	Description
Tag	WA927ZAAAAAA	A927Z - Temperature logger UHF semi-passive tag (EPC C1G2) Std
	WA927ZETAAAA	A927ZET - Temperature logger with external probe UHF semi-passive tag (EPC C1G2) Std
Development Kit	WA528BXDKAAA	A528BDK - Development kit with A528B reader, antennas, cable and demo tags
	WR1270CXDKAA	R1270C - Development kit with reader, adapter, antennas, cable and demo tags
	WR1230CBDKEU	R1230CBDK - Development kit with Quark reader, antenna, tags

Accessories

Check for the supplied accessories below:

No. 2 small screws

Installation Notice

The A927Z can be easily fixed using the 2 screws supplied. All measurements are in mm.

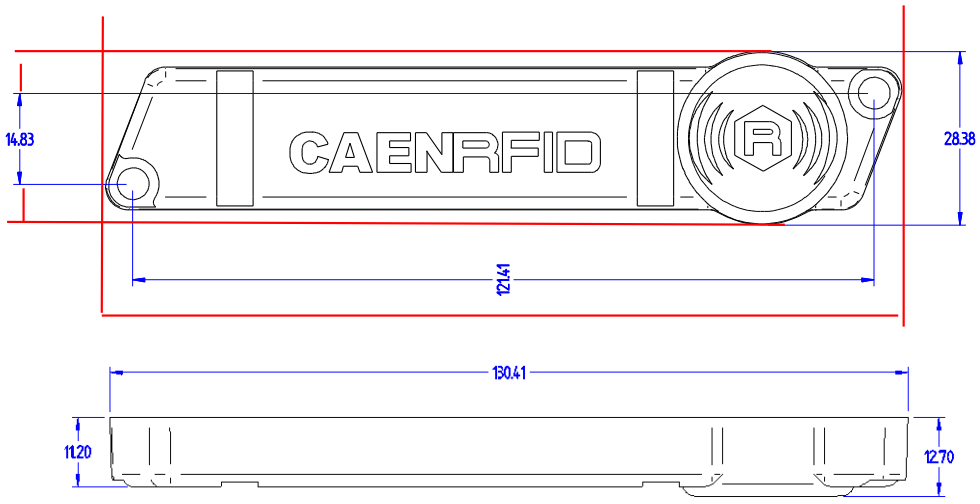


Fig. 1.3: A927Z Technical drawings

2 FUNCTIONAL DESCRIPTION

Main Features

- EPC C1G2 (ISO18000-6C) Compatible
- Long range solution
- 3 years battery life
- Battery status monitor
- Temperature range: from -30°C to +70°C
- Excellent accuracy: ±0.1°C (typ)
- No calibration required
- Programmable sampling time
- Programmable high/low temperature limit
- 8000 samples (16kbyte) Logging Memory
- Time-stamps storage
- Limit Violation Flags
- Continuous / Event logging

Application

Temperature recording during transport, storage and distribution of temperature sensitive products:

- Fresh food (fruit, vegetables)
- Seafood
- Meat and poultry
- Milk-based products
- Frozen food
- Chemical/pharmaceutical products
- Vaccine cold chain

Communication Protocol Features

- Compatible with EPC C1G2 (ISO18000-6C) protocol
- Reader to Tag link: DSB-ASK, SSB-ASK, PR-ASK 40 Kbit/s
- Tag To Reader link: FM0 40Kbit/s, Miller M=4 250/256 KHz
- 512 bit Reserved Memory
- 512 bit EPC Memory
- 208 bit TID Memory
- 17Kbyte USER Memory

- Frequency range: 860 MHz ÷ 930 MHz

Reading Performances

- 10m in air (2.5m on metal) @ 2W ERP
- Data Logging Download Time: 25 sec (8K samples)

On board Temperature Sensor

- Temperature range: from -20°C to +70°C
- Resolution: 16 bit
- Accuracy from -30°C to +70°C:
  - Typ: ±0.1°C
  - Max: ±0.75°C
- Minimum Sampling Time: 8 seconds
- Maximum Sampling Time: 18 hours
- Logging Memory Size: 8192 samples

Battery

- 3 years battery life[(1)]
- Battery status monitor (±0.1V accuracy over 2V-3.6V)
- Minimum Sampling Time: 8 seconds
- Maximum Sampling Time: 18 hours
- Logging memory size: 256 samples

[1] The activation electrical field for the tag is 0.5V/m in the range from 800MHz up to 1GHz. Users must avoid tags exposure to such an electrical field value for long time since it may seriously reduce battery life.

Sampling operating Modes

A927Z supports three programmable Sampling Operating modes:

- **Sampling Off.** Tag is working as normal ISO180006C tag. Previous logging results are readable from memory (Control register bit L=0).
- **Continuous mode.** Tag is continuously logging the measured value with interval defined by Sample Time register. All measured data is saved into memory. If desired, High or Low limit monitoring (LHM and LLM bits of control register) can also be switched on. Violation of limits will raise an alert so that it can be discovered quickly without the need of reading the whole logged memory (Control register bit L=1, bit M=0).
- **Event mode.** Tag is continuously measuring the sensor value with an interval defined by Sample Time register. If this value is violating either lower or higher limit, the value will be logged (Control register bit L=1, bit M=1).

L Sensor monitoring activated	M Mode	Sampling Mode
0	X	Sampling Off
1	0	Continuous Mode
1	1	Event Mode

Tab. 2.1: Sampling Operating Modes

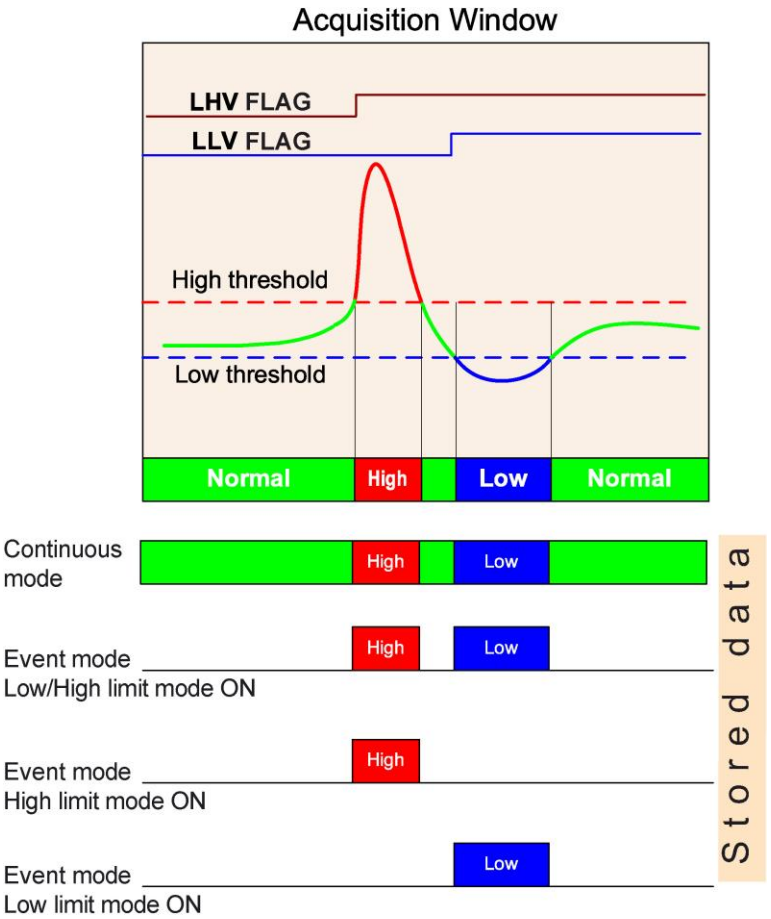


Fig. 2.1: A927Z Sampling Operating Modes

Storing operating Modes

In Continuous and Event mode, the Tag continuously measures the sensor value. When the sensor value must be stored, A927Z can be programmed to work in four different operating modes:

- **Sensor Data only.** Tag stores only the sensor data (Control register bit D = 1, bit TL =0).
- **Time-stamped Data.** Tag stores the sensor data and the corresponding time-stamp (Control register bit D= 1, bit TL=1).
- **Time-stamp only.** Tag stores only the time-stamps data (Control register bit D = 0, bit TL =1).
- **No storage.** (Control register bit D = 0, bit TL =0).

Sensor Data	Time-stamp	D Data logging activated	TL Time-stamp activated
stored	stored	1	1
stored	not stored	1	0
not stored	stored	0	1
not stored	not stored	0	0

Tab. 2.2: Storing Operating Modes

Data Logging Area Allocation

The following figure shows the data allocation used in the different storing modes described above:

Sensor Data Only	$1A0_h$	Sensor Data $_{n+3}$
	190_h	Sensor Data $_{n+2}$
	180_h	Sensor Data $_{n+1}$
	170_h	Sensor Data $_{n}$
Time-stamped Data	$1E0_h$	Sensor Data $_{n+1}$
	$1D0_h$	Time [15:00] $_{n+1}$
	$1C0_h$	Time [31:16] $_{n+1}$
	$1B0_h$	0000h
	$1A0_h$	Sensor Data $_{n}$
	190_h	Time [15:00] $_{n}$
	180_h	Time [31:16] $_{n}$
	170_h	0000h
Time-stamp only	$1A0_h$	Time [15:00] $_{n+1}$
	190_h	Time [31:16] $_{n+1}$
	180_h	Time [15:00] $_{n}$
	170_h	Time [31:16] $_{n}$

Tab. 2.3: Data Logging Area Allocation in the different storing modes

Battery measurement and behaviour

There are several options to verify the battery status.

To verify if the battery level is low, just read the failure code in the control register: the code 7 identifies a Battery Low Status (<2 V).

To verify the level of the battery, you have to enable the battery logging, and then to read the last sample value.

If you want to monitor the battery behaviour (for example during thermal stress), enable the battery logging with both continuous sampling mode and sensor data (or time-stamped data) storing mode: with this configuration the tag is continuously logging the measured data (with the defined interval). The tag stores the sensor data and you have a complete history of the battery behaviour.

3 MEMORY DESCRIPTION

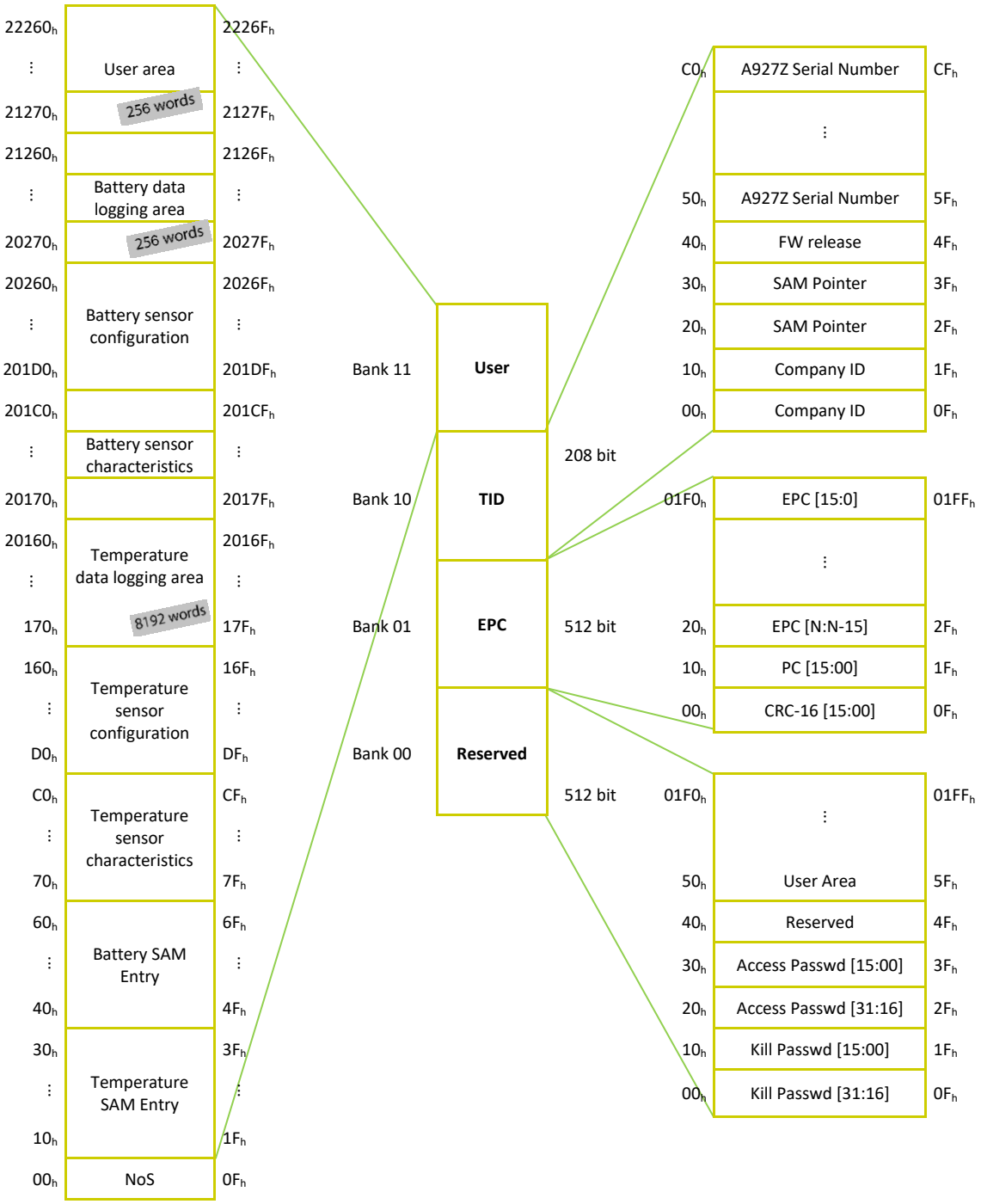
Address space

The general memory[2] layout of the A927Z tag agrees to the EPCglobal C1G2 specification (see § [RD1]). The tag memory is logically subdivided into four distinct banks. Each bank is organized into 16-bit words.

Name	Bank	Size
User Memory	11b	17484 byte
TID (Tag-identification Data)	10b	208 bit
EPC (Electronic Product Code)	01b	512 bit
Reserved Memory	00b	512 bit

Tab. 3.1: Memory banks

[2] The figures describing the A927Z memory bank configuration show the Memory bank bit address (not restricted to word boundaries). The register or memory location detailed descriptions show the Memory bank word address (restricted to word boundaries).



Tab. 3.2: Memory Bank Configuration

Reserved Memory

This bank contains the 32 bit Kill password and the 32 bit Access password according to the EPC Class 1 Gen 2 standard plus an User memory area of 432 bit.

			Initial Data
$01F0_h$	⋮	$01FF_h$	
⋮		⋮	all 0000_h
50_h	User area	$5F_h$	
40_h	Reserved	$4F_h$	0000_h
30_h	Access Passwd [15:00]	$3F_h$	0000_h
20_h	Access Passwd [31:16]	$2F_h$	0000_h
10_h	Kill Passwd [15:00]	$1F_h$	0000_h
00_h	Kill Passwd [31:16]	$0F_h$	0000_h

Tab. 3.3: Bank 00 – Reserved Memory

EPC Memory

This bank contains a CRC-16 at memory address 00h to 0Fh, a Protocol-Control (PC) at memory address 10h to 1Fh (PC initial value: 3000h), and the EPC code.

$01F0_h$	Zero Fill Area	$01FF_h$
80_h		$8F_h$
70_h	EPC Tag Encoding	$7F_h$
	⋮	
20_h	EPC Tag Encoding	$2F_h$
10_h	PC [15:00]	$1F_h$
00_h	CRC-16 [15:00]	$0F_h$

Tab. 3.4: Bank 01 – EPC Memory

EPC TAG Encoding

EPC TAG Encoding [95:00]

EPC				Bank:01b				Word addr: 2h							R/W
95				88				87							80
Year [15:00]															
79				72				71							64
Mount [7:0]								Day [7:0]							
63				56				55							48
A927Z Serial Number [15:00]															
47				40				39							32
0000h															
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
0000h															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0h				Ch				Ah				Eh			

TID Memory

TID Memory bank contains:

- Company ID.
- SAM Pointer: it allows to access to Sensor Address Map (SAM), which includes the information about the onboard sensor number and allocated memory area for each sensor.
- A927Z Firmware (FW) release.
- A927Z Serial Number.

$C0_h$	A927Z Serial Number	CF_h
	⋮	
50_h	A927Z Serial Number	$5F_h$
40_h	FW release	$4F_h$
30_h	SAM Pointer [15:00]	$3F_h$
20_h	SAM Pointer [31:16]	$2F_h$
10_h	Company ID [15:00]	$1F_h$
00_h	Company ID [31:16]	$0F_h$

Tab. 3.5: Bank 10 – TID Memory

Company ID

Company ID [31:00]

TID				Bank:10b				Word addr: 0h							R only
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
0h				0h				0h				0h			
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
5h				3h				5h				8h			

SAM Pointer

SAM pointer allows interrogator to find A927Z Sensor Address Map. Sensor Address Map contains the information about the number of available sensors and memory area definitions for each sensor. Each sensor has its own SAM entry in Sensor Address Map. This link chain is clarified in the Tab. 3.6.

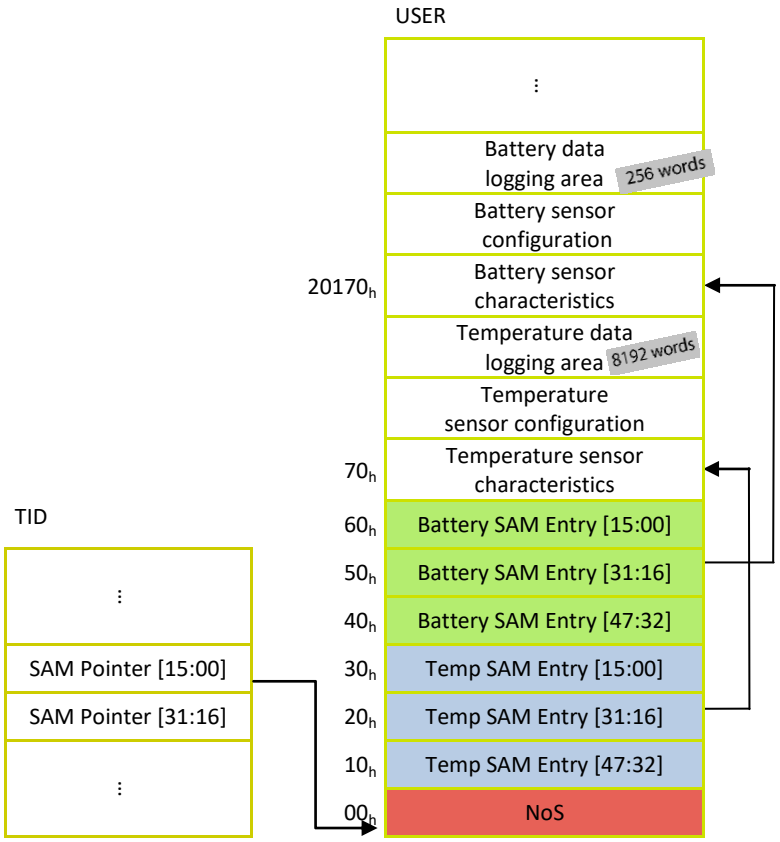
SAM Pointer [31:00]

TID						Bank:10b		Word addr: 2h							R only
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
RFU						MBS		SAM Address [23:16]							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SAM Address [15:00]															

RFU - Reserved for Future Use

MBS - Memory Bank selector value: 3

SAM Address value: 0



Tab. 3.6: SAM Pointer and SAM Entry link chain

A927Z Firmware release (FW)

The Firmware release register contains the revision number of the A927Z firmware. Firmware revision are denoted using a standard duplet of integers: Major and Minor.

A927Z Firmware release (FW) [15:00]

TID						Bank:10b		Word addr: 4h							R only
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Major [7:0]								Minor [7:0]							

A927Z Serial Number

A927Z Serial Number [127:00]

TID	Bank:10b	Word addr: 5h	R only
127	120	119	112
0000h			
111	104	103	96
0000h			
95	88	87	80
0000h			
79	72	71	64
0000h			
63	56	55	48
0000h			
47	40	39	32
Year [15:00]			

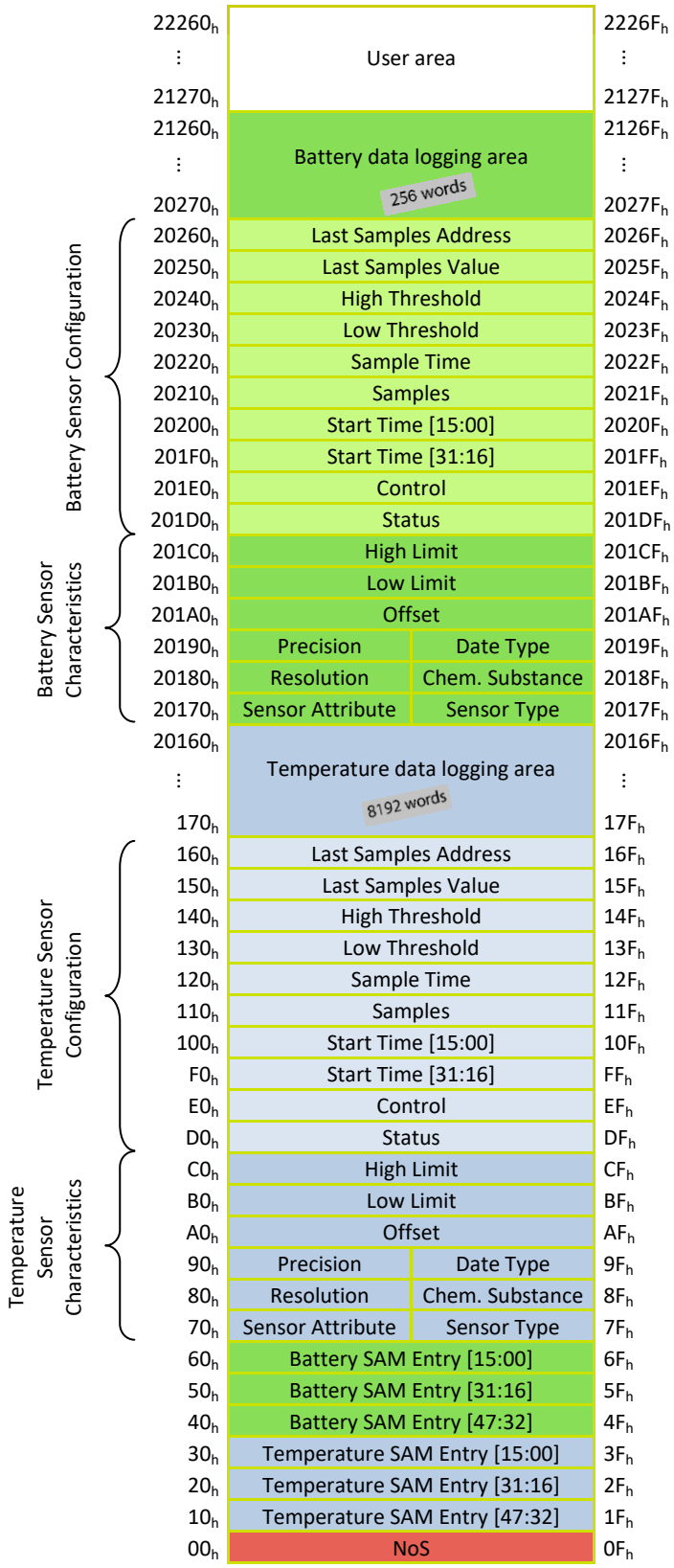
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Month [7:0]								Day [7:0]							

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
A927Z Serial Number [15:00]															

User Memory

USER Memory bank contains:

- NoS: Number of available on board sensors.
- SAM entries for each sensor. Each SAM entry contains the pointer to the beginning of the allocated memory and memory range for that specific sensor.
- Sensors memory mapped registers for Sensor descriptions. This section stores sensor identification, sensor resolution, correction data, and measurement range:
    - Temperature Sensor Characteristics
    - Battery Sensor Characteristics
- Sensor memory mapped register for Sensor operation:
    - Temperature Sensor Configuration
    - Battery Sensor Configuration
- Sensor memory data record composed of time-stamps (if time-stamp storage is enabled) and sensor value:
    - Temperature data logging area (8192 words)
    - Battery data logging area (256 words)



Tab. 3.7: Bank 11 – USER Memory

A927Z NoS description

NoS – Number of available sensors [15:00]

User					Bank:11b				Word addr: 0h							R only
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
Number of Sensors [15:00]																

Number of sensors [15:00] value:2

Temperature, Battery monitor

A927Z SAM Entry description

Number of available sensors (NoS) is stored first followed by SAM entries for each sensor. NoS is stored as 16bit unsigned integer value. Each SAM entry contains the pointer to the beginning of the allocated memory and memory range of that specific sensor. All the information related to this sensor is in the range declared into SAM entry field including characteristics, configuration and data registers.

Each sensor has its own SAM entry in Sensor Address Map.

Temperature SAM Entry [47:00]

User	Bank:11b	Word addr: 1h	R only

Battery SAM Entry [47:00]

User					Bank:11b				Word addr: 4h							R only
47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	
RFU						MBS		Sensor Address [23:16]								
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	
Sensor Address [15:00]																
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
Memory Range [15:00]																

	Temperature	Battery
MBS – Memory Bank Selector	3	3
Sensor Address [23:00]	7h	2017h
Memory Range [15:00]	2010h	110h

A927Z Sensor Characteristics Description

This section contains the description of sensors parameters:

- sensor type (code compliant to IEEE 1451)
- sensor data resolution
- sensor accuracy
- offset and measurement ranges

Sensor Attribute/Type

Temperature Sensor Attribute/Type [15:00]

User Bank:11b Word addr: 7h R only

Battery Sensor Attribute/Type [15:00]

User Bank:11b Word addr: 2017h R only

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Sensor Type [7:0]								Sensor Attribute [7:0]							

	Temperature	Battery
Sensor Attribute [7:0]	1	1
Sensor Type [7:0]	29h – Celsius Temperature	22h - Voltage

Sensor attribute 1: Time-stamp Sensor. Allows time-stamps (Unix representation) storage.

The sensor type codes are compliant to the rules specified in IEEE 1451:

Code	Base of Derived Value	Special Name	Symbol
22h	Electrical potential, potential difference, electromotive force	Volt	V
29h	Celsius Temperature	degree Celsius	°C

Resolution/Chemical Substance

Temperature Resolution/Chemical Substance [15:00]

User Bank:11b Word addr: 8h R only

Battery Resolution/Chemical Substance [15:00]

User Bank:11b Word addr: 2018h R only

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Chemical Substance [7:0]								Resolution [7:0]							

	Temperature	Battery
Resolution [7:0]	16	16
Chemical Substance [7:0]	RFU	RFU

Precision/Data Type

Precision represents the sensor accuracy expressed in tenth of the sensor base unit:

- Temperature: 0.1 °C
- Battery: 0.1 V

Temperature Precision/Data Type [15:00]

User Bank:11b Word addr: 9h R only

Battery Precision/Data Type [15:00]

User Bank:11b Word addr: 2019h R only

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data Type [7:0]								Precision [7:0]							

	Temperature	Battery
Precision [7:0]	1	1
Data Type [7:0]	RFU	RFU

Offset

To obtain the effective value of the physical parameter, the Offset Value has to be added to the Sensor data value (stored in the sensor data logging area).

Temperature Offset [15:00]

User Bank:11b Word addr: Ah R only

Battery Offset [15:00]

User Bank:11b Word addr: 201Ah R only

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Offset [15:00]															

	Temperature	Battery
Offset [15:00]	0	0

Low Limit

Low Limit is the minimum measurable value of applied parameter. It is expressed in twos complement format.

Temperature Low Limit [15:00]

User Bank:11b Word addr: Bh R only

Battery Low Limit [15:00]

User Bank:11b Word addr: 201Bh R only

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Low Limit [15:00]															

	Temperature	**Battery**
Low Limit [15:00]	FFECh (-20°C)	2 (2V)

High Limit

High Limit is the maximum measurable value of applied parameter. It is expressed in twos complement format.

Temperature High Limit [15:00]

User Bank:11b Word addr: Ch R only

Battery High Limit [15:00]

User Bank:11b Word addr: 201Ch R only

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
High Limit [15:00]															

	Temperature	Battery
High Limit [15:00]	46h (70°C)	4 (4V)

A927Z Sensor Configuration Description

For each sensor this section contains:

- Status
- Control
- Start Time
- Samples
- Sample Time
- High Threshold / Low Threshold
- Last Sample Value
- Last Sample Address

Status

Status register is read-only register containing the status flags (memory full, upper limit violation and lower limit violation flags) and Hardware status/failure code.

Temperature Status Register [15:00]

User Bank:11b Word addr: Dh R only

Battery Status Register [15:00]

User Bank:11b Word addr: 201Dh R only

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RFU Reserved for Future Use								HWF				LHV	LLV	RFU	F

HVF – Hardware Failure

A927Z general HW failure code:

0: No failure

7: Battery Low (Voltage < 2V)

6: Temperature measurement error

other values: generic failure

LLV/LHV - Limit Low/High Violation Flag

LLV and LHV bits are used as flags of limit violations. Flags are cleared automatically when tag is reset.

LLV/LHV if enabled (Control registrer LLM/LHM = 1) go to 1 when Sensor measured value is below/above the Low/High Threshold values.

	Threshold register	Control register enable bit
$LLV_{Temperature}$	Low – word addr: 13h	LLM bit – word addr: Dh
$LLV_{Battery}$	Low – word addr: 2023h	LLM bit – word addr: 201Dh
$LHV_{Temperature}$	High – word addr: 14h	LHM bit – word addr: Dh
$LHV_{Battery}$	High – word addr: 2024h	LhM bit – word addr: 201Dh

F – Memory Full Flag

F bit is raised by A927Z when Sensor data logging memory is full.

Temperature memory size: 8192 words

Battery memory size: 256 words

Control

Control register is the main configuration register. The behaviour of the sensor is mainly dependent on this register. Also resetting of sensor is done through one specific bit of this register.

Temperature Control Register [15:00]

User Bank:11b Word addr: Eh R /W

Battery Control Register [15:00]

User Bank:11b Word addr: 201Eh R /W

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RFU Reserved for Future Use					MM	SD	RST	L	D	TL	M	LHM	LLM	RFU	

MM – Memory Management

MM bit is used to control the tag behaviour in case of full memory. If this bit is clear, when the memory is full, the tag starts overwriting the memory: the tag retains the newer samples. It this bit is set, when the memory is full, the tag stops its logging activity: the tag retains the older samples. Default value is 0.

SD – Set Date

SD bit has to be set after saving the StartTime. Default value is 0.

RST - Reset

This bit has to be set when starting the new log. After tag receives a new configuration record with RST bit activated, it will reset the Samples register and do all the necessary operations to start a new log. It is automatically cleared by the tag when the required operation has been completed. Default value is 0.

L - Sensor Monitoring activated

L bit is used to control the sensor monitoring. If this bit is zero, the actual sensor value is never read. This bit turns on the system. If bit is activated, the sensor value is measured with interval defined in Sample Time register. Logging decision is done after measurement and it is dependent on the D/TL bit configuration. Default value is 0.

D - Data Logging activated

D bit is used to define if sensor value is stored into memory in case of data record is created. In most cases this bit needs to be set. If the time-stamp of specific event is the only concern, this bit can be left cleared. Default value is 0.

TL - Time stamp activated

TL bit is used to define if time-stamp is stored into memory when a data record is created. Default value is 0.

M - Mode

M bit is used for operating mode. Zero means continuous logging. Data record is created and logged always when sensor value is read (defined by Sample Time register). Bit one means that data record is created and logged only when limits are violated (and limit monitoring is turned on). Default value is 0.

LHM - Limit High Monitoring (on/off) / LLM - Limit Low Monitoring (on/off)

LHM and LLM bits are used to turn on/off the limit monitoring. This can be done even in continuous logging mode. In this case the limit violation flags in Status register are raised during logging (if limits are violated). It is fast to check the flags to determine if limits have been violated without need to read the whole memory. Default value is 0.

Start Time

Start Time register is the starting time of current log. Format of this register is Unix time-stamp format. Register can be written only when logging is not ongoing. Content of the register is totally dependent on the user since tag is not required to validate the value. Calculating the real time of logged data records is based on this time stamp.

Temperature Start Time [31:00]

User	Bank:11b	Word addr: Fh	R/W

Battery Start Time [31:00]

User	Bank:11b	Word addr: 201Fh	R/W

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Start Time [31:16]															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Start Time [15:00]															

Unix time-stamp format (or Unix time or POSIX time or Unix epoch) is the number of seconds that have elapsed since January 1, 1970 (midnight UTC/GMT), not counting leap seconds. The epoch timestamp 0 can be written in ISO 8601 format as: 1970-01-01T00:00:00Z. One epoch hour is 3600 seconds, one epoch day is 86400 seconds long, leap seconds are not calculated. The following table shows example values of Start Time register.

dec	hex	Meaning
0	0000 0000	January 1, 1970 (midnight UTC/GMT)
1197396494	475E D20E	December 11, 2007 (18:08:14 UTC/GMT)
-2147483648	8000 0000	December 13, 1901 (20:45:52 UTC/GMT)
2147483 647	7FFF FFFF	January 19, 2038 (03:14:07 UTC/GMT)

Samples

Samples register is a read-only register which gives the amount of data records in the memory. This register is incremented by the tag every time a data record is stored into memory. Samples is cleared by the tag during reset.

Temperature Samples [15:00]

User	Bank:11b	Word addr: 11h	R only

Battery Samples [15:00]

User	Bank:11b	Word addr: 2021h	R only

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Samples [15:00]															

Sample Time

Sample Time register is used to define the Sampling Time of the sensor expressed in seconds. At the same time it is the resolution of logging feature. The Number should be a multiple of 8 (minimum sampling time). The maximum sampling time is 65535 sec (≈ 18 hours). This register can be written only when logging is turned off.

Temperature Sample Time [15:00]

User	Bank:11b	Word addr: 12h	R/W

Battery Sample Time [15:00]

User	Bank:11b	Word addr: 2022h	R/W

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Sample Time [15:00]															

High Threshold / Low Threshold

HighThreshold / LowThreshold registers define the allowed (or normal) range of sensor value. Sensor can be configured to monitor when sensor value is inside/outside these limits (see Fig. 3.1: A927Z High/Low Threshold monitoring).

Temperature Low Threshold [15:00]

User	Bank:11b	Word addr: 13h	R/W

Battery Low Threshold [15:00]

User	Bank:11b	Word addr: 2023h	R/W

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Low Threshold [15:00]															

Temperature High Threshold [15:00]

User	Bank:11b	Word addr: 14h	R/W

Battery High Threshold [15:00]

User	Bank:11b	Word addr: 2024h	R/W

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
High Threshold [15:00]															

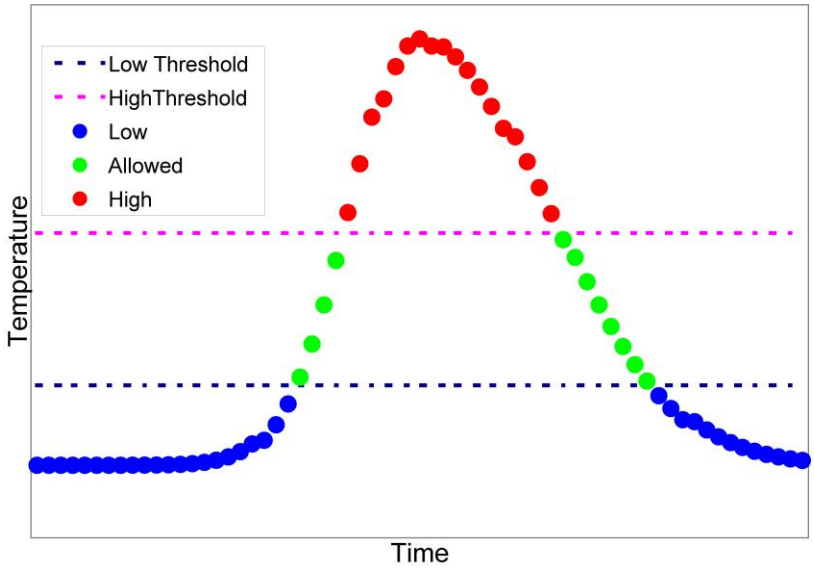


Fig. 3.1: A927Z High/Low Threshold monitoring

Last Sampled Value

Last Sampled Value is the last sensor value measured (the logging decision is done after measurement and depends on the Tag storing mode). See § Tab. 3.8 and Tab. 3.9 (pag. 27) for more information about battery and temperature data format.

Temperature Last Sampled Value [15:00]

User	Bank:11b	Word addr: 15h	R only

Battery Last Sampled Value [15:00]

User	Bank:11b	Word addr: 2025h	R only

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Last Sampled Value [15:00]															

Last Sampled Address

Last Sampled Address is the memory address of the last stored data value.

A927Z Data Logging area description

A data record is composed by a time-stamp and/or sensor value. Both are not required so one record can also be either one of these alone. Data record composition is defined by Control register.

Time-stamped Data is a 32 bit data expressed in Unix time-stamp format. It is the calculated real time of logged data record.

Sensors data value type is defined in the Sensor Characteristic section of the User memory:

	Temperature	Battery
Sensor Attribute	1 –Allows time-stamps storage	1 –Allows time-stamps storage
Sensor Type	41 – Celsius Temperature	34 – Voltage
Resolution	16 bit	16 bit
Precision	0.1°C[3]	0.1 V
Offset	0°C	0 V
Low Limit	-20°C	2.0 V
High Limit	+70°C	4 V

Data format for temperature and battery are summarized in the following tables.

Temperature (°C)	Digital output (decimal)	Digital output (HEX)
70.0	700	02BCh
60.1	601	0259h
60.2	602	025Ah
20	200	00C8h
5	50	0032h
0.1	10	000Ah
0	0	0000h
-0,1	-1	FFFFh
-5,0	-50	FFCEh
-20,0	-200	FF38h

Tab. 3.8: Temperature data format

Voltage (V)	Digital output (decimal)	Digital output (HEX)
4.0	40	0028h
3.9	39	0027h
3.0	30	001Eh
2.5	25	0019h
2.0	20	0014h

Tab. 3.9: Battery data format

[3] Typical

Registers use example

Suppose that the user wants to monitor the temperature trend for frozen food as follows:

Low Threshold (°C)	High Threshold (°C)	Sampling operating mode	Limit monitoring	Store Samples	Store Time-stamp	Sampling Interval (min.)
-20	-15	Continuous Mode	enabled	Yes	Yes	15

With this configuration the tag is continuously logging the measured data with an interval of 15 minutes. The tag stores the sensor data and the corresponding time-stamp. Violation of defined limits will raise an alert.

First of all, let's set the low and high threshold value of temperature. The data need to be converted in hex format:

	°C	HEX
Low Threshold	-20	FF38h
High Threshold	-15	FF6Ah

Then, set the Low/High Threshold registers:

- **Temperature Low Threshold:** set FF38h value in the USER memory, Bank 11b, Word address 13h
- **Temperature High Threshold:** set FF6Ah value in the USER memory, Bank 11b, Word address 14h

The sampling interval time, expressed in minutes, must be converted in seconds for the correct setting of the Sample Time register in User Memory, Bank 11b, Word address 12h:

	min	sec	HEX
Sample Time	15	900	0384h

Set the temperature start time register in the User memory, bank 11b, word address Fh. Suppose the date 15 Jun 2010 07:00, data need to be converted in Unix time-stamp format:

Human time	dec	HEX
Tue, 15 Jun 2010 07:00:00 GMT	1276585200	4C1724F0 h

Now configure the **Control Register:**

Turn on the limit monitoring by setting LHM (**Limit High Monitoring)** and LLM (**Limit Low Monitoring)** bits=1 in the Temperature Control Register in the USER memory, Bank 11b, Word address Eh.

In this way LLV (**Limit Low Violation Flag**) and LHV (**Limit High Violation Flag**) in the **Status register** bits go to 1 when the value of temperature measured by the sensor is below/above the defined values for the Low/High Threshold.

In this example we consider a **continuous** sampling operation mode, so set the bit L=1 and bit M=0 in the Temperature Control Register in the USER memory, Bank 11b, Word address Eh.

Then define the **storing operating mode** (Time-stamped data in this example) setting Control register bit D= 1, bit TL=1:

Set SD bit=1 (SD has to be set after saving the Start Time).

Set reset bit RST=1(this bit has to be set when starting the new log).

The control register is now set as follows:

15…11	10	9	8	7	6	5	4	3	2	1	0
RFU	MM=0	SD=1	RST=1	L=1	D=1	TL=1	M=0	LHM=1	LLM=1	RFU	

In this example, the sensor is logging with a sampling interval of 15 minutes. It is possible to verify temperature limits violation simply by reading LLV and LHV bits in the Status register, without the need of reading the whole logged memory.

4 TECHNICAL SPECIFICATION

Technical Specifications Table

Tag Type	Semipassive
RFID Interface	UHF EPC Class1 Gen2/ISO 18000-6C compatible
Reserved memory size	512 bit
EPC memory size	512 bit
TID memory size	208 bit
Reserved memory size	512 bit
User Memory size	17484 byte
Access control	yes
Memory retention	100 years
Memory endurance	10000 cycles
Read range	10m in air (2.5m on metal) @ 2W ERP
Frequency range	860 MHz ÷ 928 MHz
Write time	100 µsec
Alarms	User-configurable high temperature and low temperature alarms
Battery Life	3 years typical (depending on usage and operating temperature)
Battery Type	Li / MnO2 Model Renata CR 2450N
Operating temperature	-30°C to +70°C
Storage temperature	-40°C to +85°C
Absolute temperature range	-40°C to +70°C
Temp. Resolution	±0.1°C
IP Rating	IP67
Dimensions (L, W, H)	130.4 x 23.4 x 12.7 mm^3
Weight	35 g

Tab. 4.1: A927Z Technical Specifications

Warnings:

- Do not incinerate, the product contains lithium battery.
- The activation electric field for the tag is 0.5 V/m in the range from 800 MHz up to 1 GHz. Prolonged exposure to electric fields greater than this value must be avoided in order to preserve the battery life.

Air Link Protocol Characteristic

Physical Layer

The A927Z tag in general satisfies the EPCglobal C1G2 physical layer protocol specification (see § [RD1]) with exception of the following points:

- **Reader to tag data rates:** interrogator shall communicate using Tari value of 25 µsec only. Tari values of 12.5 µsec and 6.25 µsec are not supported.
- **Tag to reader encoding:** the encoding format, selected in response to interrogator commands can be either FM0 or Miller (M=4) as specified in [RD1] chapter 6.3.1.3.2. Miller data encoding with M=2 and M=8 are currently not supported.
- **Tag to reader data rates:** the A927Z tag supports tag to interrogator data rates and link frequencies as specified in the following table:

DR Divide Ratio	TRcal[4]	LF Link Frequency	Encoding Type
8	200 µsec	40 kHz	FM0
64/3	66.6 µsec	320 kHz	Miller M=4
64/3	83.3 µsec	256 kHz	Miller M=4
64/3	85.3 µsec	250 kHz	Miller M=4

- **Session:** Session S1 has an infinite persistence time, so have the S2 and S3 sessions.
- **Commands:** all the EPC C1G2 mandatory commands are supported as well as the optional Access command.

[4] TRcal: Tag-to-Interrogator calibration symbol

Typical Characteristics

A927Z Battery Life

The A927Z battery life depends on the working temperature range and on the sampling interval as follows:

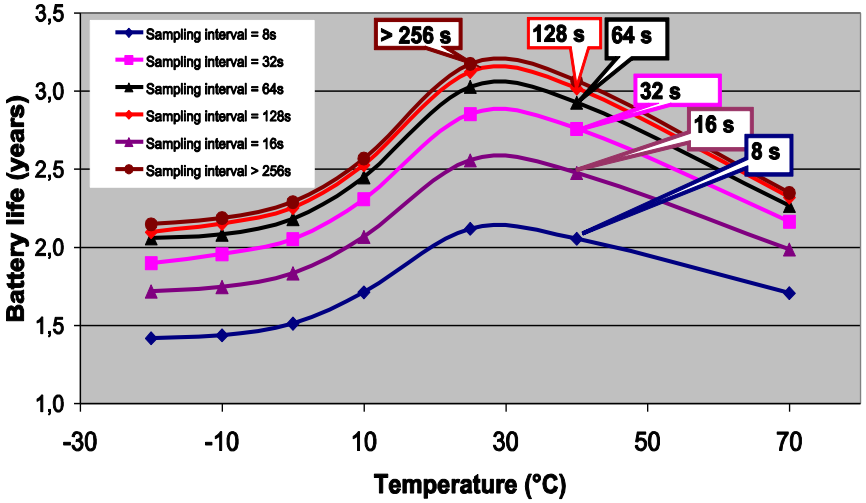


Fig. 4.1: A927Z Battery life (typ.)

Response Time

In the following figure, the A927Z temperature response times is shown.

T90 value is the time (measured in seconds) needed by the tag to reach 90% of the change in temperature. If the tag's temperature is plotted against time, an exponential graph will result, initially changing quickly then flattening out in the final stages.

If the tag at 25°C is placed into an environment at 70°C then the temperature change is 45°C (70°C -25°C). 90% of 45°C is 40,5°C so the T90 value will be the time taken for the tag to go from 25°C to 65,5°C (25°C + 40,5°C), as shown in the figure below:

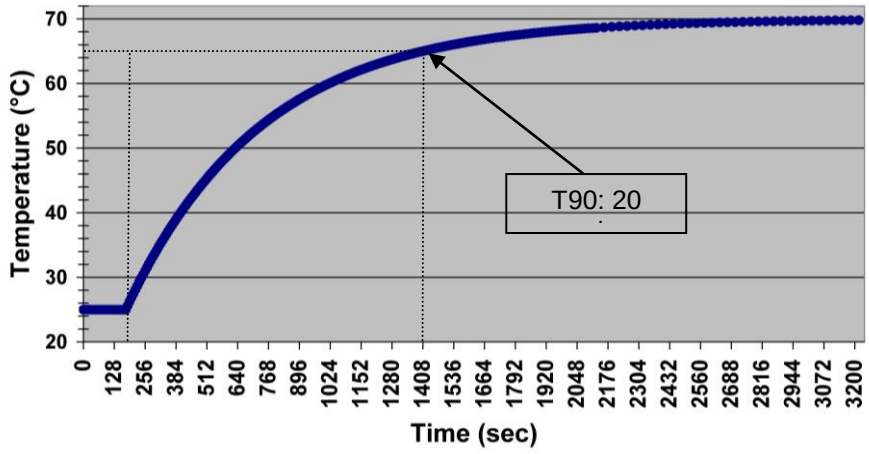


Fig. 4.2: A927Z Response Time

Accuracy

The typical tag accuracy over the operating temperature range (from -30°C to +70°C) has an accuracy error curve. At high temperatures the magnitude of error slightly increases. The tag accuracy is of ± 0.1°C (typical) and ± 0.75°C (max).

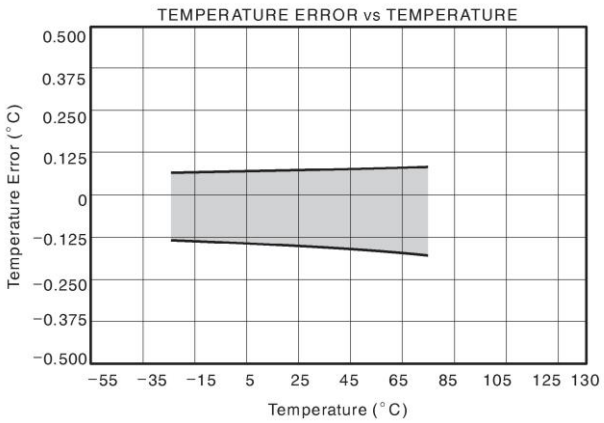


Fig. 4.3: Temperature error vs Temperature

The following figure shows the A927Z accuracy at room temperature (25°C):

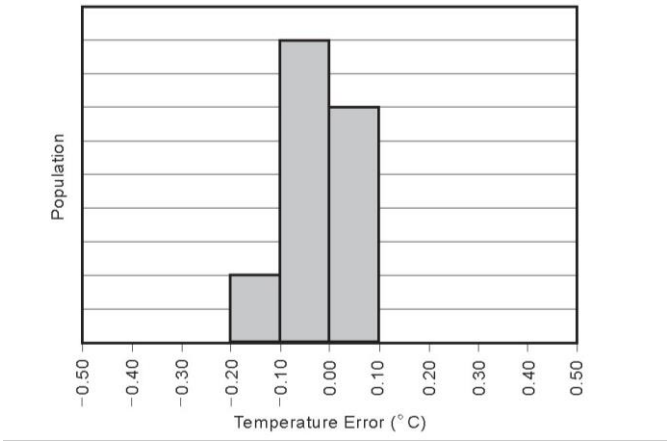


Fig. 4.4: Accuracy at 25°C

Theoretical read range

The read range depends on the frequency, as shown in figure below:

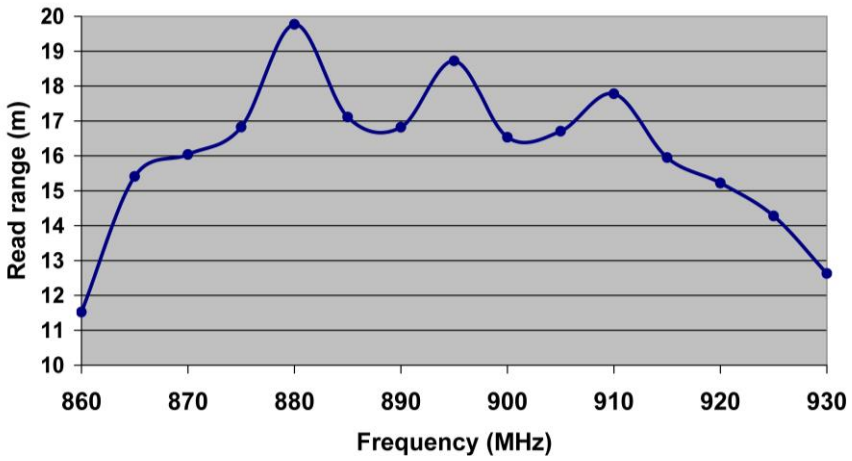


Fig. 4.5: A927Z Theoretical read range at 2W ERP

5 REGULATORY COMPLIANCE

FCC Compliance

Not Required for UHF Semipassive Tag.

CE Compliance

Reference standard:

ETSI EN 301 489-1 V2.2.3

ETSI EN 301 489-3 V2.1.1

ETSI EN 302 208 V3.1.1

EN 55032:2015

EN 55035:2017+/AC:2019

EN 62368-1:2014+/AC:2015+/A11:2017

See § ***A927Z CE Declaration of Conformity*** page 34 for the A927Z CE Compliance Certificate.

EN 12830 Compliance

Reference standard:

EN 12830:1999 - Temperature recorders for transport, storage and distribution of deep frozen/quick frozen food and ice cream-Tests, performance and suitability.

Reference document: A927Z EN1230 Test report [RD2].

See § ***A927Z EN 12830 Declaration of Conformity*** page 35 for the A927Z EN 12830 Compliance Certificate.

Enclosure degree of protection

Reference standard:

CEI EN EN 60529

Reference document: TesLab 09B204A [RD3]

RoHS EU Directive

easy2log© A927Z Temperature logger UHF semi-passive tag is compliant with the EU Directive 2015/863/EU on the Restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS3).

A927Z
CE DECLARATION OF CONFORMITY

We

CAEN RFID Srl
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55049 Viareggio (LU)
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Tel.: +39.0584.388.398 Fax: +39.0584.388.959
Mail: info@caenrfid.com
Web site: www.caenrfid.com

herewith declare under our own responsibility that the product:

Code: **WA927ZAAAAAA**

Description: **A927Z - Temperature logger UHF semi-passive tag (EPC C1G2) Std**

corresponds in the submitted version to the following standards:

ETSI EN 301 489-1 V2.2.3

ETSI EN 301 489-3 V2.1.1

ETSI EN 302 208 V3.1.1

EN 55032:2015

EN 55035:2017+/AC:2019

EN 62368-1:2014+/AC:2015+/A11:2017

and declare under our sole responsibility that the specified product meets the principle requirements and other applicable regulations of directives 2014/53/EU (RED) and 2015/863/EU (RoHS3)

Date: 03/03/2021

CAEN RFID srl
Via Vetraia, 11
55049 VIAREGGIO - ITALY
VAT IT 02032050466

Adriano Bigongiari (Chief Executive Officer)

On the basis of this declaration, this product will bear the following mark: CE

A927Z
EN 12830 DECLARATION OF CONFORMITY

We

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55049 Viareggio (LU)
Italy
Tel.: +39.0584.388.398 Fax: +39.0584.388.959
Mail: info@caenrfid.com
Web site: www.caenrfid.com

herewith declare under our own responsibility that the product:

Code: **WA927ZAAAAAA**

Description: **A927Z - Temperature logger UHF semi-passive tag (EPC C1G2) Std**

corresponds in the submitted version to the following standards:

EN 12830:1999 - Temperature recorders for transport, storage and distribution of deep frozen/quick frozen food and ice cream-Tests, performance and suitability.

According to the EN 12830:1999 standard, the classification of the devices is the following:

Climatic environment: D

Logger type: device with internal sensor to be used inside cold room

Temperature measurement operating range: -30°C to +70°C

Temperature measurement absolute range: -40°C to +70°C

Storage temperature range: -40°C to +85°C

Accuracy class: 1

Date: 07/07/2017

Adriano Bigongiari (Chief Executive Officer)

EN 12830 Compliance Matrix

§	Requirement	Compliance	Note
4.1	The means used by the themometer must be independent of any temperature measurement which is used to control the refrigeration system	Yes	Independent stand alone self powered loggers
4.2	The measurement range of the sensors must be <-25 °C >15 °C with minimum span of 50°C	Yes	Temperature measurement operating range is -30°C to +70°C
4.3	The time and date of the beginning shall be readable and any settings which configure the recording shall be protected against un-authorised or accidental modification	Yes	All data inside memory can be password protected according to EPC Class1 Gen2 standard
4.4.1	At least the time and temperature shall be recorded. The place of measurement has to be indicated	Yes	Time and temperature are recorded. The user memory of the tag (54 byte) can be used to store the place of measurement
4.4.2	It shall be possible to identify and consult the charts and the recorded data. Records shall be available for at least one year	Yes	All records are identified and stored on the users system indefinitely
4.5	Devices with an autonomous power supply shall be marked as such with an indication of the temperature range. An indication of battery life is desirable	Yes	The recommended operating range is reported on the user manual. The battery charge status can be detected through RFID interface
4.6	The degree of protection shall be at least IP20, IP55 or IP65 for different environments	Yes	Degree of protection is IP 67[5]
4.8.5	Electrical power disturbances and susceptible to radiated electromagnetic field	Yes	See test report[6]
4.9.2.1	Under rated operating conditions the recorder shall have a maximum error of ±1°C and a resolution of better than ±0.5°C	Yes	Resolution is 0.1°C. Temperature accuracy is +/-0.1°C (typical), +/-0.75°C (worst case)[7]
4.9.2.2	The maximum recording interval for transport shall be 5m for recording durations shorter than 24 Hrs and 15m for 1-7 days and 60m for durations longer than 7 days. For storage, the recording interval shall be 60m	Yes	The recording interval is fully programmable from 8s to 18hours
4.9.2.3	The manufacturer shall specify the recording capacity as either duration at a given interval or as a number of readings	Yes	The recording capacity is 8k samples (temperature only) or 2k samples (temperature and timestamp)
4.9.2.4	The maximum relative timing error shall be better that 0.2% for up to 31 days and 0.1% for durations > 31 days	Yes	The maximum timing error is 0.01%[3]
4.9.2.5	Response Time shall have a maximum response time of 60 min. (90%)	Yes	The response time is 20min. [3]
4.9.3.1 Tab 3D	The standard operating range is -30 to +70 °C operationally and -40 to +85 °C for storage	Yes	See test report [3]
4.9.3.2	The equipment shall withstand vibration from 5Hz to 8.6 Hz 10mm amplitude and 8.6Hz to 150 Hz acceleration of 3g	Yes	See test report[8]
4.9.3.3	The equipment shall withstand shocks with the following characteristics: acceleration 10g, duration 10ms, number of shocks 1	Yes	See test report[4]
4.10	The data shall be protected against alteration	Yes	All data inside memory can be password protected according to EPC Class1 Gen2 standard

[5] TesLab s.r.l. - Environmental Test Report – A927Z UHF Semi-Passive Logger Tag - Ref.TesLab 09B204A
[6] GSD s.r.l. – CE Test Report - A927Z UHF Semi-Passive Logger Tag - Ref. 29346A
[7] CAEN RFID s.r.l. internal test report: A927Z EN 12830 Test Report – 01/03/2010
[8] GSD s.r.l. – Vibration Test Report – A927Z UHF Semi-Passive Logger Tag - Ref. 29340