Temperature Sensor, Logger & UHF RFID Transceiver

Peel "N" Stick Logging Temperature Sensor

Powered by Opus™ IC

Peel"N"Stick Logger

Introduction

The AZN5200, Peel"N"Stick label, is a full-featured temperature logger & UHF RFID transceiver based on Axzon's Opus™ IC. AZN5200 low-cost label style temperature sensor is used for wirelessly tracking temperature sensitive products through the logistics supply chain. By recording temperature to a non-volatile Flash Memory, the AZN5200 provides an end-to-end temperature log throughout a products journey to the customer. The data is encrypted and recorded directly to the on-chip Flash Memory providing a high level of data security.

The Logger (AZN5200) operates from a battery, for up to three weeks, and autonomously measures and records the temperature of any item throughout its journey. The temperature log can be accessed wirelessly as it passes through a UHF RFID portal at waypoints in the logistics channel or by a handheld reader. If no RFID reader is available the AZN5200 can be configured to flash an LED status of the condition above or below a set temperature.

Additional features of the AZN5200 include a FingerSpot™ sensor that can be used to start the temperature logging and tamper detection via a tear-off strip and ambient light level sensor.

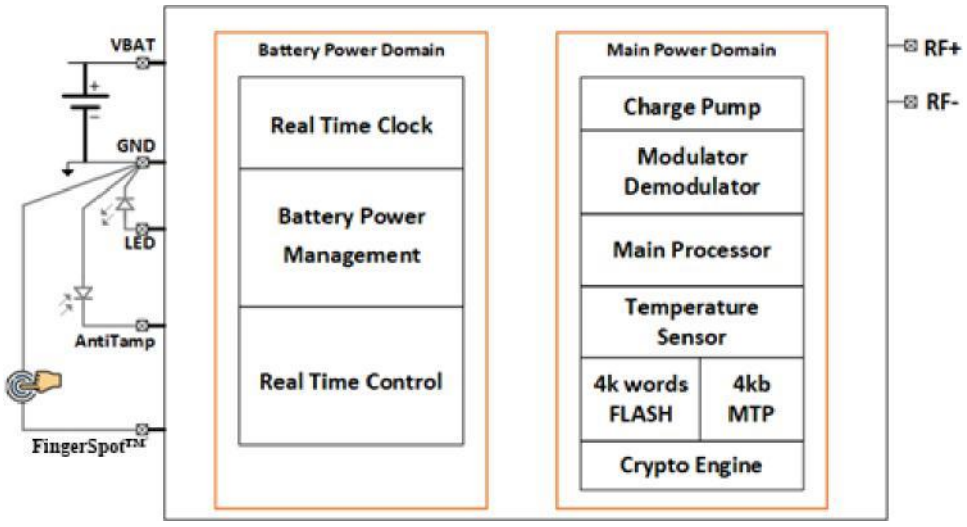
AZN5200

Features:

- RFID Performance
  - Worldwide RAIN UHF Operation (860-960 MHz)
  - ISO/IEC 18000-63 Compliant
  - EPCglobal™ Gen2 (v.2.0.1) Compliant
  - Chameleon™ Self-Tuning RF Front End
  - On-Chip RSSI (OCRSSI) Received Power Sensor
  - -14 dBm Passive Read Sensitivity (Flash Read)
  - -22 dBm Battery Assisted Read/Write Sensitivity
- Data Logging
  - 4096 Data Sample Flash Memory
  - Real Time Clock with 0.2% Accuracy
  - User programmable logging Intervals, 30Secs to 8hrs
  - Delayed Logging from Timer or FingerSpot™
- Security
  - 128-bit Unique Identifier (TID)
  - 128-bit EPC
  - Sample Date Authentication
  - Password Control of all TID, EPC and USER Memory Banks
  - 128-bit AES ENC Key
  - 128-bit AES MAC Key
  - Uninterruptible Logging
  - Flash Can Not be Written Over the Air
- Temperature Sensor
  - -40°C to +85°C Operating Range
  - 2pt Factory Calibration (30°C and 60°C)
  - Temperature Resolution 0.125°C
  - +/- 0.5°C from 30°C to 60°C, Typical
  - +/- 1.0°C from -25°C to 85°C, Typical
  - Optional User Calibration
- Energy Management
  - 1nA Standby Current
  - 100nA Logging Current
  - 21 Days of Logging from a 100 uAHr Battery
  - Battery Monitor (Min. 1.8V)
- Tamper Detection
  - Anti-Tamper, with two options
    - Tear Strip, or
    - Photo Diode
  - Tamper Status Logged with Temperature Data
- LED Driver
  - LED Blink Pattern indicates two States
    - Armed and Active Logging, and
    - Temperature Set Point Alarm
    - Anti Tamper detection Alarm
  - Toggle Continuous or On Demand (by FingerSpot™)

Functional Block Diagram

A block diagram of the AZN5200 IC is provided in Figure 1. The major blocks are as follows:



(fig. 1 AZN5200 Functional Blocks)

Real-Time Clock

The real-time clock operates continuously after the battery is activated. At this point the logging label will be in the Standby State.

Logging Configuration

The logging configuration of the logging label is highly user configurable and is accomplished by writing a set of instructions using an RFID reader. After the configuration step the Logger is armed and in the Ready State.

Real-Time Controller

The Real-Time Control block controls all of the AZN5200 functions as configured by the Logging Configuration step . These include timing of Logging Events, LED display operation, and monitoring the FingerSpot™ and Anti-Tamper pins. The Logger configuration data is transferred to the Real-Time Control block when the product is armed.

Charge Pump

The Charge Pump harvests power from the incoming RF signal to power the Logger during passive operation.

RF Transceiver

The RF Transceiver parses incoming RF commands and transmits data back to the Reader using backscatter modulation of the carrier.

Main Processing Module

The Main Processing Module performs all the logical operations of the Logger during passive operations and Logging Events.

MTP (Multi-Time Programmable) Memory

The MTP memory is a non-volatile memory that can be read and written by the reader (when not locked). The MTP memory contains all the configuration data for the Logger as well as all of the EPC Gen2 specified memory locations, such as the TID and EPC data.

Temperature Sensor

The Temperature Sensor block includes a PTAT (Proportional To Absolute Temperature) solid-state temperature sensor as well as an analog-to-digital converter (ADC) to digitize process the PTAT voltage. The temperature data is, encrypted and secured and written into flash memory.

Flash Memory

The Flash Memory is a non-volatile memory block used to hold the logging data (measured temperature and tamper flag). Data is only written into the Flash Memory by the Logger, it can only be read by the Reader, and is encrypted and secured and written into flash memory. The Flash Memory capacity is 4k samples.

Crypto Block

The encryption engine is used to encrypt the logging data stored in the Flash memory. Alternatively, the encryption engine can be used to append an encrypted authentication word to the logging data so that the recipient can detect that the data has been altered by a third party since being read from the Logger.

The Battery Power Domain

The Battery Power Domain is powered from the battery after the Logger is taken out of the Sleep State. Once energized, the Battery Power Domain is held at 1.5V until the logging is completed or the battery falls below the Minimum Battery Threshold.

The Battery Monitoring Engine

AZN5200 includes a dedicated ADC to check the battery voltage at each Logging Event to ensure that the temperature measurement is valid.

The Main Power Domain

The Main Power Domain can be powered by the battery or passively from the incoming RF signal. The Main Power Domain is powered by the battery during Logging Events and during Battery Assisted Passive operation (BAP Mode). During passive communication with the Reader, the Main Power Domain is powered by harvested RF energy.

Logger States

During normal operation, the Logger progresses through a series of states under command from the Reader. Moving through these states is generally irreversible. This is necessary to prevent hackers from tampering with the logging data, or the logging configuration, once the Logger is logging.

No Battery State

Before a battery is installed in the Logger the Battery Power Domain is not energized and the Real-Time Control block is in reset. During this time the Logger can still communicate passively with the Reader (using harvested RF power). The Reader generally has full access to the MTP Memory in the No Battery State. In this state, the Reader can write EPC data or User data. The Reader can also write configuration data that can be transferred to the Real-Time Control block later. If the battery is ever removed the Logger returns to the No Battery State and all logged data is lost.

Sleep State

When a battery is attached to the Logger, the device enters the Sleep State. During the Sleep State, the battery remains isolated and no power is available to the Battery Power Domain. In this state the current drain on the battery is extremely low (≤1 nA at room temperature). This current drain determines the shelf life of the Logger.

Standby State

The Logger will move from the Sleep State to the Standby State in response to a command from an RFID Reader. At this time the battery is connected internally, the Battery Power Domain is energized, and the Real-Time Clocks begin to run. From this point forward the battery drain increases to roughly 100 nA at room temperature. This power signature defines the operating life of the Logger.

Ready State

The Logger enters the Ready State when the Real-Time Clock is set. At this time, all of the Configuration Data required by the Real-Time Control block is transferred from the MTP Memory to the Real-Time Control block. This transfer will only happen once. From this point on the configuration of the Logger is fixed. Further writes to the MTP Memory configuration registers will have no effect. In the Ready State, the Logger is ready to begin Logging. The Logger can be configured to start logging immediately, after a predetermined number of logging intervals, or upon activation of the FingerSpot™.

Logging State

The Logger will transition from the Ready State to the Logging State in one of three ways depending on the configuration. The Logger may enter the Logging State (begin Logging) either a) immediately after reaching the Ready State, b) after a fixed delay (integer number of Logging Intervals, or c) after the FingerSpot™ is touched. Once Logging begins, it will not stop until the specified number of Logging Events has been completed, the Flash Memory is full, or the battery voltage drops below the Minimum Battery Threshold. While in the Logging State, the Logger can still be accessed by a reader using passive RF communication. Passive RF communication is blocked during a logging event (typically 80ms).

Data Security

The Logger includes several features to protect the configuration of the Logger and to guarantee data integrity.

The Logger supports all the standard EPC Gen2 security features including passwords for each bank of MTP memory. In many applications, these password features will not need to be used. This is particularly true if the Logger is taken from the Sleep State to the Ready State in one, secure reader session.

As discussed above, once the Real-Time Clock is set and the Logger enters the Ready State, the Logger configuration is transferred from MTP memory to the Real-Time Control block. From this time forward, the configuration of the Logger cannot be changed unless the battery is physically removed. In addition, the MTP locations used to report alarm status are read only for the reader. Alarms can only be set by the Logger and cannot be cleared by the reader. Depending on password controls, it may still be possible to write to the MTP memory during the Ready State or the Logging State, but changes there will no longer impact the logging function. The Logger will continue to run with the original configuration until the logging session is complete.

The logging data stored in the Flash memory is protected in several ways. First, the Flash memory can only be written by the Logger itself. The Flash memory is read only for the reader. Second, the logging data can be encrypted as it is read from by reader using a 128-bit encryption key. Alternatively, the logging data can have an authentication code appended to it. The authentication code is encrypted with a 128-bit encryption key. Using the authentication code the end user can determine if the logging data has been altered even after the data has been read by a reader and passed to a third party and stored in a data archive. The Logger supports four choices when reading logging data;

1. Clear Data, No Authentication Code
2. Encrypted Data, No Authentication Code
3. Clear Data with Authentication Code, or
4. Encrypted Data with Authentication Code

Chameleon™ Technology Overview

Chameleon™ technology is a novel self-tuning mechanism that enables tags to remain properly tuned over a wide range of frequencies and environmental conditions. The Chameleon™ engine autonomously adjusts Magnus's impedance to optimize the match to the attached tag antenna for every set of conditions. The net result is consistent tag sensitivity and performance across frequencies with automatic correction for frequency-dependent antenna parameters, antenna detuning due to environment (such as moisture accumulation), and any other physical mechanism that leads to an impedance mismatch between the chip and the antenna.

AZN5200 Performance Data

Powered by wireless Opus™ IC

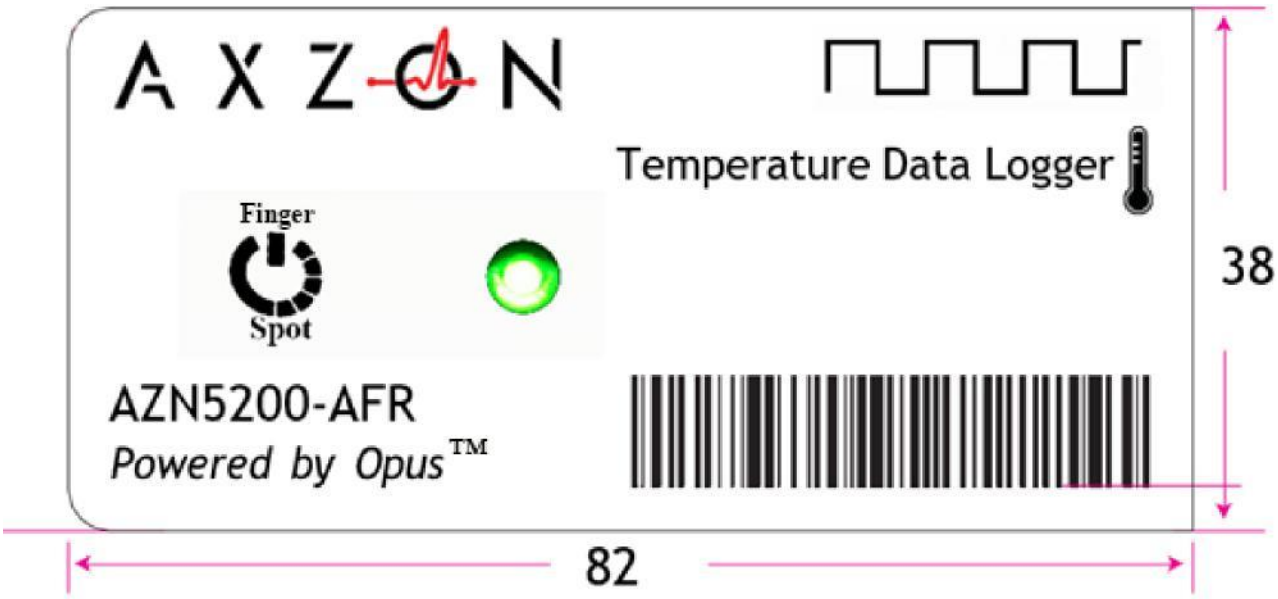
Table 1: Key Parameters

PARAMETER	Min	Typ	Max	Units	Notes
IC Compliance	EPC class 1 gen 2 v2.0.1; ISO 18000-63				1
Operating Temp Range	-40		+85	°C	
Passive Read Sensitivity		-12.0	0	dBm	2
Passive Write Sensitivity		-12.0	0	dBm	2
Battery Assisted Read Sensitivity (BAP)		-22.0	0	dBm	3
Battery Assisted Write Sensitivity (PAB)		-22.0	0	dBm	3
Current Consumption (Deep Sleep State)		< 1		nA	4
Current Consumption (Configuration State)		130		nA	5
Battery Input Voltage Range	1.8		3.0	Volts	
Equivalent Input resistance		6		ohms	6
Equivalent Input capacitance		1.5		pF	6
TID memory	1024 bits (64 words)				
EPC memory	256-bits (16 words)				
User memory (Flash)	4,096 words of log data				
User memory (MTP)	2304 bits (144 words)				
Reserved memory	320 bits (20 words)				

NOTES:

1. Gen2v2 with Data Read protection largely compliant with ISO/IEC 18000-63 32-bit Access Password AES128 Data Integrity, Data Secrecy
2. No battery connected.
3. Battery connected.
4. Deep Sleep State (Logging Off, RTC Off).
5. Configuration State (Logging Off, RTC On)
6. At –12.0 dBm input power.

Physical Dimensions



Dimensions in mm

Environmental Information (Battery)

Axzon's AZN5200 Temperature Logger uses a thin, flexible, and printed power source, that meets the requirements of REACH (Registration, Evaluation, and Authorization of Chemicals) including the Candidate List of substances of very high concern (SVHC).

Additionally, the battery complies with the European directive 2006/66/EC of the European Parliament and the Council on batteries and accumulators and waste batteries and accumulators (known as the battery directive).

The European Directive of the Restriction of the Use of certain Hazardous Substances (2002/95/EC) in electrical and electronic equipment (RoHS directive) restricts the use of hazardous substances such as lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE). This directive does not apply to batteries. However, the battery AZN5200 uses does comply with the requirements regarding the restricted substances.

Also, the battery is within the limits set in the European Directive 94/62/EC on packaging and packaging waste for using lead, mercury, cadmium, or hexavalent chromium in packaging and packaging inks and is compliant with the US packaging legislation (CONEG) for using lead, mercury, cadmium, or hexavalent chromium in packaging and packaging inks.

Battery safety information can be found by visiting www.Axzon.com

Patent Notification

This product is covered by one or more U.S. patents 7586385, 8081043, and other Axzon's granted and pending patents. Visit the Axzon website (https://axzon.com/patents/) for the latest patent information. Chameleon™, Opus™, FingerSpot™, and Magnus® are trademarks of Axzon, Inc. as well as the product and service names mentioned herein are registered trademarks of Axzon, Inc. All other trademarks are the property of their respective owners, Axzon, Austin Texas, USA.