AND9450/D

Reader Firmware and API Considerations

ON Semiconductor®

www.onsemi.com

APPLICATION NOTE

Introduction

The almost exclusive role for UHF RFID readers to date has been the rapid performance of high−reliability inventories of large numbers of RFID tags, with the EPC™ code being the primary item of interest. As a result, off−the−shelf reader firmware and APIs are optimized for inventory functionality and do not efficiently handle passive sensing.

ON Semiconductor's Battery Free Wireless Sensor tags powered by a Magnus®−S integrated circuit (IC) family of sensing RFID chips are fully compliant with the EPC Generation−2 UHF RFID specification, but can most effectively utilize existing reader hardware after the firmware and API have been optimized for sensing. This note describes (1) potential reader API and firmware limitations, (2) sensing applications requiring continuous wave (CW) support, and (3) an optimal sensor read procedure.

Common Reader API and Firmware Limitations

Magnus−S IC generate multiple sensing outputs that can be accessed by the reader − for example, the Sensor Code, On−Chip RSSI Code, and Temperature Code (See Application Note AND9213 for more information). Sensor circuitry can require activation by the sending of a Generation−2 SELECT command by the reader, and output values are retrieved using Generation−2 READ commands. Typically, sensor outputs are read multiple times as quickly as possible and post−processed in order to complete a measurement.

Almost all readers are capable of performing these commands and accessing sensor data, but their efficiency is often limited by certain factors.

Limitations on the Number of SELECT Commands in an Inventory

If the reader API or firmware only allows one SELECT command at the beginning of an inventory round, then the On−Chip RSSI Code and Temperature Code cannot be read in the same round, as each requires its own SELECT command. A new inventory round must be run, and the tag singulated again before the other code can be accessed, significantly increasing the time required to read both codes.

Limitations on the Number of READ Commands in an Inventory

Reader APIs often allow only one READ command in each inventory round. Multiple words can generally be retrieved with a READ single command, but only if they are located in consecutive addresses in memory. Since some Magnus−S chips locate their sensor data in nonconsecutive addresses, this limitation can require multiple inventory rounds and multiple singulations of the same tag in order to read all of the sensor outputs.

Separation of EPC−Reading and Tag−Memory−Access

Since reading EPC codes is much more common task than accessing tag memory in a generic RFID inventory process, some readers have one primary API call that reports EPC codes, and a separate secondary call to access tag memory. In a sensing application, the tag memory must be read just as often as the EPC code, so requiring two separate calls can reduce efficiency.

Inability to Hop Channels before the Maximum Dwell Time is Reached

Legal regulations require readers to channel−hop among a set of frequencies, without transmitting too long (exceeding the dwell time) on any one channel within a specified larger time window. For sensing applications, it is often desirable to channel−hop well before the maximum dwell time is reached, in order to read the Sensor Code at many different frequencies as quickly as possible.

Incorrect Assumption of Nonvolatile Tag Memory Data

Some reader inventory procedures may assume that tag memory is entirely nonvolatile, and persists from one inventory round to the next. However, sensor outputs are stored in volatile memory and are lost at the end of each inventory round. Accordingly, the SELECT commands which trigger the calculation of the On−Chip RSSI and Temperature Codes must be in the same inventory round with the READ commands which access them, with no interruption in reader power.

Unnecessary Verification of SELECT Command Data

Some readers automatically execute a READ command on the data at the address specified by a SELECT command, in order to verify that the data actually passes the SELECT mask criterion. The motivation is to guard against the possibility that a non−passing tag replies to the reader because it did not successfully receive the SELECT.

This process is unnecessary for sensing applications and can increase the overall read time. Also, since sensor SELECT commands are used to activate sensor calculations, not to test the contents of nonvolatile memory, additional problems could result.

Inability to Change Certain SELECT Command Parameters

Some reader APIs or firmware do not allow certain SELECT command parameters to be edited before an inventory round. These parameters need to be set appropriately for the reader to activate the On−Chip RSSI and/or Temperature sensing engine. One of these parameters is the mask length, which needs to be set to 0 in order to activate temperature. If the reader API or firmware does not allow this, then it will not be able to read temperature.

For RSSI measurements, to guarantee that the mask will match the sensor tag, regardless of its receive power, mask bit 5 can be set to 0 and the threshold set to the maximum value of 11111, resulting in an 8−bit mask of 00011111 or HEX code 1Fh. Both of these SELET command parameters are covered in more detail in AND9213 p.2.

Continuous Wave (CW) Needs of Sensors

Some sensing functions built into RFID chips need quiet power supplies for best accuracy. Typical RFID commands consist of a modulated carrier with about 95% modulation depth when the reader sends a command to the tag followed by CW that the tag can use to backscatter the required data. Since no EPC Generation−2 command exists specifically to support sensors, the standard set of commands do not provide a way to start a sensor then provide unmodulated CW while it runs. Ideally, a DELAY command would exist which would instruct the reader to pause and emit CW for a user−defined amount time at a specifiable point in an inventory round. In Magnus−S sensors, calculation of the Temperature Code requires this quiet power supply condition. After sending the SELECT command to trigger the Temperature Code calculation, the reader should transmit CW for a minimum of 3 ms by executing a DELAY command. The Temperature Code will be calculated during this period of low−noise CW, and then the inventory will continue normally.

An Optimal Sensor Read Procedure

An optimal read procedure allows for multiple SELECT commands, multiple READ commands, and an optional DELAY command (see section “Continuous Wave Needs of Sensors”), all within a single inventory round. An outline of the procedure is below.

1. Begin the inventory round by transmitting an arbitrary number of SELECT commands in a specifiable order to activate sensor calculations and filter tags in the field.
2. Execute a DELAY command for a user−defined amount of time, on the order of milliseconds (see section “Continuous Wave Needs of Sensors”). The user should also have the ability to omit this step.
3. Singulate a tag using the QUERY/ADJUST/REP/ACK procedure described in the EPC Specification and get its EPC.
4. Execute an arbitrary number of READ commands for the singulated tag, to access possibly nonconsecutive blocks of memory in any bank.
5. Repeat steps 3 and 4 until it becomes likely that all of the applicable tags in the field have been read, then end the inventory round.
6. Report the channel frequency, EPCs, and read results of all tags that were inventoried in this round to the user.
7. Hop to the next channel frequency, even if the dwell time has not been reached, and prepare to return to step 1.

Conclusion

Since passive sensing tags generally require the reading of multiple memory locations to upload sensed data to the reader, communication efficiency can be greatly increased by providing an optimized inventory procedure in the reader API that allows for multiple SELECT and READ commands in a single inventory round.

Sensor tags also may have requirements for CW to enable best accuracy for some sensors. A custom DELAY command enabling the reader to hold CW output between standard EPC Gen2 commands enables best accuracy for these tags.

Magnus is a registered trademark of RFMicron, Inc.
EPC is a trademark of EPCglobal, Inc.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5817−1050

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative