Application Note

SL900A

RFID Interface Device Setup Guide

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1 General Description

This document presents a guide how to configure SL900A device (transponder) with a UHF RFID reader using the Gen2 and cool-Log™ command set. It shows various use cases and the necessary command sequences for the correct setup of the transponder.

2 Temperature Reading

The temperature measurement using the internal sensor of the transponder can be implemented in fully passive and battery-assisted mode. Both cases require the same command sequence between reader and the transponder.

The following command sequence should be implemented in order to acquire temperature reading:

1. Put the transponder into the OPEN state (Query, ACK, Req_RN)
2. Send the cool-Log™ command: GET SENSOR VALUE

   E0 AD 01 [handle][CRC-16]

   This command will trigger the AD conversion. The SL900A transponder will reply with:

   - AD error flag [1 bit]
   - RF current limiter value [5 bits]
   - AD output code [10 bits]
   - Handle [16 bits]
   - CRC [16 bits].

3 Dense Temperature Logging

Dense temperature logging is the default mode of operation and can be used in any temperature monitoring application. In this mode the SL900A can store the maximum number 841 temperature data points in its measurement memory (EEPROM).

In this example the SL900A is configured as follows:

- Log mode – dense
- Storage rule – normal
- Sensor enable – temperature
- Log interval – 5 minutes
- Delay time – 0 seconds
- Delay mode – timer
- IRQ+timer – disabled
- Number of words for application data – 0
- Start time – January 6th, 2011, 11:30:00 AM

The following command sequence should be implemented in order to setup dense temperature logging:

1. Put the transponder in Open state (Querry, ACK, Req_RN).

2. Send the “Set Log Mode” command:

   E0 A1 02 02 58 [Handle] [CRC-16]

   This sets up the logging mode, storage rule, sensor enable and log interval.
3. Send the “Initialize” cool-Log™ command:

   E0 AC 00 00 00 00 [Handle] [CRC-16]

   This sets up the delay time, delay mode, IRQ + timer option and number of words for user data.
4. Send the “Start Log” cool-Log™ command:
5. **E0 A7 04 4C B7 80 [Handle] [CRC-16]**

   This starts the logging procedure and writes the starting time. The year offset for the starting time is 2010.

4 Out of Limits Temperature Logging with Delay Time 12 Hours

In this logging mode only the temperature points that are outside the specified limits, are stored. This way the temperature data in the EEPROM is compressed/reduced to be able to concentrate only on “important” events. This mode assumes that the data inside the upper and lower limits is OK and does not need to be stored in the EEPROM. The 4 limits are used in the limits comparator for the decision if the value is going to be stored in the EEPROM and for the limits counters increment. The limits counters are incremented each time a value is outside the limits regardless of the logging mode that is set up (works also in the dense mode).

In this example the following transponder configuration is set up:

- Log mode – dense
- Storage rule – normal
- Sensor enable – temperature
- Log interval – 5 minutes
- Delay time – 12 hours
- Delay mode – timer
- IRQ + timer – disabled
- Number of words for application data – 0
- Start time – January 6th, 2011, 11:30:00 AM
- Extreme upper limit – 30°C
- Upper limit – 25°C
- Lower limit – 15°C
- Extreme lower limit – 10°C
- Vo1 and Vo2 voltage references – default

The following command sequence should be implemented:

1. Put the transponder in Open state (Querry, ACK, Req_RN).
2. Send the “Set Log Mode” cool-Log™ command:

E0 A1 22 02 58 [16 bits Handle] [16 bits CRC]

This sets up the logging mode, storage rule, sensor enable and log interval.

3. Send the “Set Log Limits” cool-Log™ command:

   E0 A2 81 A2 29 66 75 [16 bits Handle] [16 bits CRC]

   This set up the log limits to the upper values.

4. Send the “Initialize” cool-Log™ command:

   E0 AC 05 40 00 00 [16 bits Handle] [16 bits CRC]

   This sets up the delay time, delay mode, IRQ+timer option and number of words for user data.

5. Send the “Start Log” cool-Log™ command:

   E0 A7 04 4C B7 80 [16 bits Handle] [16 bits CRC]

   This starts the logging procedure and writes the starting time. The year offset for the starting time in this case is 2010.

5 Set up an External Capacitive Sensor and perform Sensor Conversion

The procedure here should be used only the first time after the SFE parameters are changed. The first time the “Start Log” and “End Log” cool-Log™ commands need to be sent in order that the new SFE parameters are copied from the EEPROM to the internal set up registers.

In this example the following settings are set up:

- Sensor – external sensor 1 (EXT1) in capacitive mode with DC excitation
- Vo1 and Vo2 voltage references – default

The following command sequence should be implemented:

1. Put the transponder in Open state (Querry, ACK, Req_RN).
2. Send the “Set SFE Parameters” cool-Log™ command:

   E0 A4 00 20 [16 bits Handle] [16 bits CRC]

   This sets up the sensor front end to the capacitive sensor with DC excitation.

3. Send the “Start Log” cool-Log™ command:

   E0 A7 00 00 00 00 [16 bits Handle] [16 bits CRC]

   This commands initiates the read-out of the new SFE parameters into the setup registers. The starting time can be 0 or the current real time.

4. Send the “End Log” cool-Log™ command:

   E0 A6 [16 bits Handle] [16 bits CRC]

   This stops the logging procedure. This step can be omitted if logging needs to be activated.

5. Send the “Get Sensor Value” cool-Log™ command:

   E0 AD 01 [16 bits Handle] [16 bits CRC]

   This command starts the AD conversion and reads the result. The SL900A transponder replies with:

   - AD error flag [1 bit]

- Seti value [5 bits]
- AD output code [10 bits]
- Handle [16 bits]
- CRC [16 bits]

6 Determining the Transponder State

The procedure here should be used to determine the SL900A setup and log state. This should be used each time before a reader intends to read the log data, read the number of sensor points and memory pointer.

The following command sequence should be implemented:

1. Put the transponder in Open state (Querry, ACK, Req_RN).
2. Send the “Get Measurement Setup” cool-Log™ command:
   E0 A3 [16 bits Handle] [16 bits CRC]
   The SL900A transponder replies with:
   - start time [32 bits]
   - log limits [40 bits]
   - logging form [3 bits]
   - storage rule [1 bit
   - sensor enable flags [4 bits]
   - log interval [15 bits]
   - delay time [12 bits]
   - delay mode [1 bit]
   - IRQ+timer flag [1 bit]
   - number of words for application data [8 bits]
   - handle [16 bits]
   - CRC [16 bit]
3. Send the “Get Log State” cool-Log™ command:
   E0 A8 [16 bits Handle] [16 bits CRC]
   The SL900A transponder replies with:
   - limit counters [32 bits]
   - measurement address pointer [10 bits]
   - number of memory replacements (used for rolling mode) [6 bits],
   - number of measurements [15 bits]
   - active flag (logging enabled) [1 bit]
   - status flags [8 bits]
   - handle [16 bits]
   - CRC [16 bits]

7 Writing and Reading Data from the FIFO

This procedure is used if the FIFO is used for communication between a microcontroller connected to the SPI interface and a UHF RFID reader. The FIFO can be used for fast data transmission as the reader and microcontroller do not need to write the data to the EEPROM. The FIFO is 8 bytes deep.

In this example the reader writes 7 bytes of data with the values:

- 0x11, 0x22, 0x33, 0x44, 0x55, 0x66, 0x77

The following command sequence should be implemented:

1. Put the transponder in Open state (Querry, ACK, Req_RN).
2. Send the “Access FIFO” cool-Log™ command to read the FIFO status:

   E0 AF C0 [16 bits Handle] [16 bits CRC]

   The FIFO status byte holds the information about the number of valid bytes in the FIFO, if the data is ready and from which side the data was written in. In this example we assume that the FIFO is completely empty, so the SL900A transponder will return the value:

   20 [16 bits Handle] [16 bits CRC]
3. Send the “Access FIFO” cool-Log™ command to write in 7 bytes of data:

   E0 AF A7 11 22 33 44 55 66 77 [16 bits Handle] [16 bits CRC]
4. Send the “Access FIFO” cool-Log™ command to read the FIFO status:

   E0 AF C0 [16 bits Handle] [16 bits CRC]

   Now that the FIFO already has 7 bytes loaded the SL900A transponder replies with:

   57 [16 bits Handle] [16 bits CRC]
5. Send the “Access FIFO” cool-Log™ command to read 7 bytes from the FIFO:

   E0 87 [16 bits Handle] [16 bits CRC]

   The SL900A transponder replies with:

   11 22 33 44 55 66 77 [16 bits Handle] [16 bits CRC]

8 Set up the System password and open device to read system data

This procedure is used to write in a new System password in case the current System password is 0 (which is the factory default). In this case the complete System password is written in order to enable read/write protection. After that the reader opens the device and reads the measurement setup parameters.

In this example the System password is set to:

- 0xAA, 0xBB, 0xCC, 0xDD

The following command sequence should be implemented:

1. Put the transponder in Open state (Querry, ACK, Req_RN).
2. Send the “Set Password” cool-Log™ command:

E0 A0 01 AA BB CC DD [16 bits Handle] [16 bits CRC]

This command writes the 32-bit password to the System password location and enables the password protection.

3. Send the “Get Measurement Setup” cool-Log™ command:

   E0 A3 [16 bits Handle] [16 bits CRC]

   This command tries to read the measurement set up parameters, but the SL900A transponder replies with an error code:

   [Header bit = 1] A0 [16 bits Handle] [16 bits CRC]

4. Send the “open Area” cool-Log™ command with the correct password:

   E0 AE 01 AA BB CC DD [16 bits Handle] [16 bits CRC]

   This command opens access permission to the system memory bank.

5. Send the “Get Measurement Setup” cool-Log™ command:

   E0 A3 [16 bits Handle] [16 bits CRC]

   Now the SL900A replies with the measurement setup parameters:

   - start time [32 bits]
   - log limits [40 bits]
   - logging form [3 bits]
   - storage rule [1 bit]
   - sensor enable flags [4 bits]
   - log interval [15 bits]
   - delay time [12 bits]
   - delay mode [1 bit]
   - IRQ + timer flag [1 bit]
   - number of words for application data [8 bits]
   - handle [16 bits]
   - CRC [16 bits]

9 Set up Application memory and enable password protection

This procedure is used to reserve memory space in the User memory bank for application data and to set up the measurement data protection. Application data and Measurement data have separate passwords protection, so that the system can be designed in such a way that different readers have different access permissions.

In this example the following settings are set up:

- Number of words for application data – 12
- Application password – 0xE4, 0x78, 0x30, 0x1B

The following command sequence should be implemented:

1. Put the transponder in Open state (Querry, ACK, Req_RN).
2. Send the “Initialize” cool-Log™ command:

E0 AC 00 00 0C 00 [16 bits Handle] [16 bits CRC]

This command reserves the first 12 words in the User memory bank for application data. No measurement data will be written to this memory locations and the application password will be used to protect data in this location.

3. Send the “Set Password” cool-Log™ command:

   E0 A0 02 E4 78 30 1B [16 bit Handle] [16 bits CRC]

   This commands writes the 32-bit password to the Application password location and enables the password protection for the application data.

10 Set up the Shelf life algorithm

This procedure is used to set up the parameters required for the dynamic shelf life calculation. It shows how to reserve the required look-up table in the application memory area.

In this example the following settings are set up:

- Number of words for application data: 30 (for 60-byte look-up table)
- Application password (write protection): 0x00 0x00 0x55 0x66
- Tmax – 0xA5
- Tmin – 0x12
- Tstd – 0x56
- Ea – 0x7C
- Slinit – 0xAC31
- Tinit – 0x12A
- Shelf life sensor ID – 0
- Enable negative shelf life – disabled
- Start time – January 6th, 2011, 11:30:00 AM

The following command sequence should be implemented:

1. Put the transponder in Open state (Querry, ACK, Req_RN).
2. Send the “Initialize” cool-Log™ command:

   E0 AC 00 00 1E 00 [16 bits Handle] [16 bits CRC]

   This commands reserves the first 30 words in the User memory for the shelf life look-up table.
3. Write in the look-up table using 30 “BlockWrite” commands (also “Write” commands can be used) starting in User memory bank address 0x00 to 0x1D. “BlockWrite” commands are preferred here to reduce communication overhead.
4. Send the “Set Password” cool-Log™ command:

   E0 A0 01 00 00 55 66 [16 bits Handle] [16 bits CRC]

   This command write-protects the look-up table so that it cannot be modified with a reader without access permission.
5. Send the “Set Shelf Life” cool-Log™ command:

E0 AB A5 12 56 7C AC 31 4A 84 [16 bit Handle] [16 bit CRC]

This command sets up the shelf life parameters and enables the shelf life algorithm.

6. Send the “Start Log” cool-Log™ command:

   E0 A7 04 4C B7 80 [16 bits Handle] [16 bits CRC]

   This starts the logging procedure with shelf life.

11 Contact Information

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13 Revision Information

Changes from 1-00 (2013-Jun-06) to current revision 1-01 (2014-Jul-22)	Page
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Note: Page numbers for the previous version may differ from page numbers in the current revision.