Application Note

SL900A

cool-Log™ Command Set

Content Guide

1 General Description

This document provides a detailed description of the cool-LogTM command set supported by the SL900A device. The SL900A device complies with the EPC Gen2 standard. The cool-Log™ command set is defined in compliance with the EPC Gen2 custom command specification.

For a detailed description of EPC Gen2 mandatory commands, please refer to the EPC Gen2 specification.

2 Supported Commands Overview

Table 1: Supported EPC Gen2 Command Overview

#	Command	Command Code	Security Level	Description
01	QueryRep	0b00	-	Inventory Command – decrement slot number
02	ACK	0b01	-	Inventory Command – Acknowledge RN16
03	Query	0b1000	-	Inventory Command – pick new slot and reply if 0
04	QueryAdjust	0b1001	-	Inventory Command – Update Q and pick new slot
05	Select	0b1010	-	Select Command – Criteria based tag selection
06	NAK	0xC0	-	Inventory Command – Not Acknowledge
07	Req_RN	0xC1	-	Access Command – Request new 16 bit RN (handle)
08	Read	0xC2	2, 3	Access Command – Read block in memory bank
09	Write	0xC3	2, 3	Access Command – Write to block in memory bank
10	Kill	0xC4	-	Access Command – Kill transponder (SPI remains)
11	Lock	0xC5	-	Access Command – Locks selected memory bank
12	Access	0xC6	-	Opt. Access Cmd – Move transponder to secure state
13	BlockWrite	0xC7	2, 3	Opt. Access Cmd – Write blocks in memory bank
14	BlockErase	0xC8	2, 3	Opt. Access Cmd – Erase blocks in memory bank

The cool-Log™ commands are defined as EPC Gen2 custom commands. All custom commands have a 2 byte command code. The 1st byte is defined as 0xE0 while the 2nd byte selects a specific cool-Log™ command listed in the table below.

Table 2: cool-Log™ Command Overview

#	Command	Command Code	Security Level	Description
1	Set Password	0xA0	1, 2, 3	Sets the passwords for the selected password level.
2	Set Log Mode	0xA1	1	Sets the logging mode.
3	Set Log Limits	0xA2	1	Sets the measurement limits for limits logging mode.
4	Get Measurement Setup	0xA3	1	Returns the measurement setup registers from system memory.
5	Set SFE Parameters	0xA4	1	Sets parameters for the external sensor front-end.
6	Set Calibration Data	0xA5	1	Sets the calibration data for the internal temperature sensor and timer.
7	End Log	0xA6	1	Stops the logging function and moves the chip to standby.
8	Start Log	0xA7	1	Starts the timer and the selected logging function.
9	Get Log State	0xA8	1	Returns the logging state of the chip.
10	Get Calibration Data	0xA9	1	Returns the internal and external calibration data.
11	Get Battery Level	0xAA	-	Measures and returns the battery voltage.
12	Set Shelf Life	0xAB	-	Sets shelf life parameters.
13	Initialize	0xAC	1	Initializes the chip and sets the size of the user memory area and the logging start delay.
14	Get Sensor Value	0xAD	-	Measures and returns the selected sensor value.
15	Open Area	0xAE	-	Enables access to the specified EEPROM area.
16	Access FIFO	0xAF	-	Reads or writes the 8-byte FIFO register (for fast SPI to RFID interface transfer).

3 cool-Log™ Commands

3.1 Set Password (0xA0)

In addition to the Gen2 Lock protection the SL900A allows to read-protect and write-protect its specific memory areas. The Set Password command enables a 32-bit password protection for the selected memory area:

- System memory area
- Application memory area
- Measurement memory area

Each 32-bit password is divided into two 16-bit passwords. The lower 16 bits are used for write protection while the upper 16 bits allow read/write protection. The password protection is immediately effective in case the password value is non-zero. Upon a successful reception of the Set Password command the transponder will backscatter the response within 20ms. Password protection is active only for the RFID interface.

When the System memory area is open for writing, the Set Password command can change the passwords for all 3 password levels.

If the System area is write-protected, the Set Password Command:

- cannot change the System password.
- can change the Application password, if open.
- can change the Measurement password, if open.

Table 3: Set Password Command (0xA0)

SOF	Custom	Command Code	Password Level	Password	Handle	CRC
Frame-Sync	0xE0	0xA0	8 bits	32 bits	16 bits	16 bits

Password Level:

- Bit 1:0 Security Level:
  - [0, 0]: Not allowed.
  - [0, 1]: Level 1 – System Memory Area
  - [1, 0]: Level 2 – User Memory Area
  - [1, 1]: Level 3 – Measurement Memory Area
- Bit 7:2 All zeros

Password:

Physical Address	Data		Function
000 h,	System Password	[31:24]	System Password – Read/Write Protection
001 h	System Password	[23:16]	
002 h	System Password	[15:8]	System Password – Write Protection
003 h	System Password	[7:0]	
004 h	Application Password	[31:24]	Application Password – Read/Write Protection
005 h	Application Password	[23:16]	
006 h	Application Password	[15:8]	Application Password – Write Protection
007 h	Application Password	[7:0]	
008 h	Measurement Password	[31:24]	Measurement Password – Read/Write Protection
009 h	Measurement Password	[23:16]	
00A h	Measurement Password	[15:8]	Measurement Password – Write Protection
00B h	Measurement Password	[7:0]	

Table 4: Tag reply to a successful Set Password command

SOF	Header	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	16 bits	16 bits	1 Dummy bit

3.2 Set Log Mode Command (0xA1)

The Set Log Mode command sets various parameters which are used during logging operation. This command defines the logging form (memory storage type), storage rule, enables sensors inputs and sets the logging interval. In case the command is executed successfully SL900A will respond within 20 ms.

Table 5: Set Log Mode Command (0xA1)

SOF	Custom	Command Code	Log Mode	Handle	CRC
Frame-Sync	0xE0	0xA1	24 bits	16 bits	16 bits

Log Mode:

- Bit 0 RFU
- Bits 15:1 Log Interval:
  - LSB = 1 second
  - Maximum = 16384 seconds
- Bit 16 Battery Check Enable
- Bit 17 Temperature Sensor Enable
- Bit 18 External Sensor 2 Enable
- Bit 19 External Sensor 1 Enable
- Bit 20 Storage Rule:
  - Normal [0]: When the logging area in the EEPROM is full, the chip does not store new sensor data to the EEPROM, but it will still increment the measurement counter and RTC.
  - Rolling [1]: When the logging area is full the chip continues with writing new sensor data to the EEPROM form the beginning of the logging area. Thus the chip overwrites the old stored data and increments the “Number of memory replacements [5:0]” field in the System status group.
- Bits 23:21 Logging Form:
  - **Dense [0, 0, 0]:**

    All values are stored to the measurement area. No time information is stored along with the measurement values.
  - **Out of Limits [0, 0, 1]:**

    All values that are outside the specified limits are stored to the measurement area. The limit comparison is done with the selected sensor. Additionally the measurement number is stored along with to the sensor value.
  - **Limit Crossing [0, 1, 1]:**

    Only measurement values which are crossing any set limits are stored. Limits comparison is done with the selected sensor.

Additionally the measurement number is stored along with to the sensor value.

- **IRQ – EXT1 [1, 0, 1]:**
  Interrupt triggered based on external sensor input EXT1.
- **IRQ – EXT2 [1, 1, 0]:**
  Interrupt triggered based on external sensor input EXT2.
- **IRQ – EXT1, EXT2 [1, 1, 1]:**
  Interrupt triggered based on external sensor input EXT1 and EXT2.
- **All other:**
  RFU

Table 6: Tag reply to a successful Set Log Mode Command

SOF	Header	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	16 bits	16 bits	1 Dummy bit

3.3 Set Log Limits Command (0xA2)

The Set Log Limits command defines the limits used during the logging operation. All 2 limits are 10 bit values.

Table 7: Set Log Limits Command (0xA2)

SOF	Custom	Command Code	Log Limits	Handle	CRC
Frame-Sync	0xE0	0xA2	40 bits	16 bits	16 bits

Log Limits:

- Bits 9:0 Extreme upper limit
- Bits 19:10 Upper limit
- Bits 29:20 Lower limit
- Bits 39:30 Extreme lower limit

Table 8: Tag reply to a successful Set Log Limits Command

SOF	Header	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	16 bits	16 bits	1 Dummy bit

3.4 Get Measurement Setup Command (0xA3)

The Get Measurement Setup command reads the current configuration of SL900A. This command returns data from 4 different system memory locations:

- Start Time (physical address: 0x00F:00C)
- Log Limits (physical address: 0x01D:019)
- Log Mode (physical address: 0x026)

- Delay Time (physical address: 0x029:02A)

Table 9: Get Measurement Setup Command (0xA3)

SOF	Custom	Command Code	Handle	CRC
Frame-Sync	0xE0	0xA3	16 bits	16 bits

Table 10: Tag reply to a successful Get Measurement Setup command

SOF	Header	Start Time	Log Limits	Log Mode	Log Interval	Delay Time	Application Data	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	32 bits	40 bits	8 bits	16 bits	16 bits	16 bits	16 bits	16 bits	Dummy bit [1]

Start Time:

- Bits 5:0 Second
- Bits 11:6 Minute
- Bits 16:12 Hour
- Bits 21:17 Day
- Bits 25:22 Month
- Bits 31:26 Year

Log Limits:

- Bits 9:0 Extreme upper limit
- Bits 19:10 Upper limit
- Bits 29:20 Lower limit
- Bit 31:30 Extreme lower limit

Log Mode:

- Bit 0 Battery Check Enabled
- Bit 1 Temperature Sensor Enabled
- Bit 2 External Sensor EXT2 enabled
- Bit 3 External Sensor EXT1 enabled
- Bit 4 Storage Rule:
  - [0]: Normal
  - [1]: Rolling
- Bit 7:5 Logging Form
  - [0,0,0] Dense
  - [0,0,1] Out of Limits
  - [0,1,1] Limits Crossing
  - [1,0,1] IRQ – EXT1

- [1,1,0] IRQ – EXT2
- [1,1,1] IRQ – EXT1, EXT2

Log Interval:

- Bit 0 RFU
- Bits 15:1 Log interval in seconds

Delay Time:

- Bit 0 IRQ + Time Enable
- Bit 1 Delay mode:
  - [0]: Timer
  - [1]: External Switch
- Bits 3:2 RFU
- Bits 15:4 Delay Time

Application Data:

- Bits 2:0 Broken Word Pointer
- Bits 6:3 RFU
- Bits 15:7 Number of words for application data

3.5 Set SFE Parameters Command (0xA4)

The Set SFE Parameters command writes the Sensor Front End parameters to the memory. Those parameters include the range preset values for the external sensor inputs, external sensor types and the also the sensor that will be used for limits comparison (Verify Sensor ID).

Table 11: Set SFE Parameters Command (0xA4)

SOF	Custom	Command Code	SFE Parameters	Handle	CRC
Frame-Sync	0xE0	0xA4	16 bits	16 bits	16 bits

SFE Parameters:

- Bit 1:0 Verify Sensor ID:
  - [0,0]: first selected sensor
  - [0,1]: second selected sensor
  - [1,0]: third selected sensor
  - [1,1]: fourth selected sensor
- Bit 2 Auto- Range Disable
- Bit 3 EXT2:
  - [0]: linear conductive sensor
  - [1]: high impedance input (voltage follower), bridge

- Bits 5:4 EXT1:
  - [0,0]: linear resistive sensor
  - [0,1]: high impedance input (voltage follower), bridge
  - [1,0]: RFU
  - [1,1]: capacitive or resistive sensor without DC (AC signal on EXC pin)
- Bits 10:6 Seti: External sensor 1 range (current source value).
- Bits 15:11 Rang: External sensor 2 range (resistor feedback ladder).

Table 12: Tag reply to a successful Set SFE Parameters Command

SOF	Header	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	16 bits	16 bits	Dummy bit [1]

3.6 Set Calibration Data Command (0xA5)

The Set Calibration Data Command writes to the calibration block in the EEPROM memory. The calibration data is preset during manufacturing, but can also be changed in the application if needed.

Note: This command will write to the EEPROM only and will not update the calibration values in the calibration registers. The calibration registers are automatically updated with each START LOG command.

Some calibration settings can be modified by the application while other parameters denoted by "DO NOT MODIFY" should not be altered as this could degrade the temperature sensing performance and the communication stability.

Table 13: Set Calibration Data Command (0xA5)

SOF	Custom	Command Code	Calibration Data	Handle	CRC
Frame-Sync	0xE0	0xA5	56 bits	16 bits	16 bits

Calibration Data:

- Bit 1:0 RFU
- Bit 2 exc_res: Excitation for resistive sensors without DC
- Bits 6:3 reftc: Bandgap voltage temperature coefficient – **Do not modify!**
- Bits 13:7 off_int: Temp. conversion offset calibration
- Bits 18:14 ring_cal: Main system clock oscillator calibration – **Do not modify!**
- Bits 20:19 irlev: Voltage interrupt level for external sensors – ratiometric
- Bits 22:21 selp22: POR voltage level for a 3V system
- Bit 23 sw_ext_en: Controlled battery supply for external sensors – the battery voltage is connected to the EXC pin
- Bits 31:24 df: RTC oscillator calibration
- Bits 36:32 adf: Main reference voltage calibration – **Do not modify!**
- Bits 38:37 selp12: POR voltage level for a 1.5V system

- Bit 39 gnd_switch: Lower AD reference voltage to GND (default. = 1)
- Bits 42:40 coarse2: **Vo2** adjustment
- Bits 47:43 ad2: Higher AD reference voltage – fine– **Do not modify!**
- Bits 50:48 coarse1: **Vo1** adjustment
- Bits 55:51 ad1: Lower AD reference voltage – fine – **Do not modify!**

Table 14: Tag reply to a successful Set Calibration Data Command

SOF	Header	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	16 bits	16 bits	Dummy bit [1]

Offset Calibration

In order to compensate the variations of the sensor accuracy the bits off_int (Bits[13:7]) can be used to correct the conversion data of SL900A with known and controlled values. The off_int bits are interpreted as two's complement. Therefore the result can be change in positive and negative direction. The change in AD result for one LSB depends on the selected resolution (Vo2-Vo1).

For example: Using the temperature sensor and the default reference voltage a LSB step, changes the temperature result of 0.18°C.

In case an external voltage output sensor is used the default LSB change would result to 0.3 mV (1 LSB = 310mV / 1023).

3.7 End Log Command (0xA6)

The End Log command stops the logging operation and turns the real time clock off. It also clears the Active flag in the System Status field in the EEPROM. The IC is left in the passive (standby) mode.

Table 15: End Log Command (0xA6)

SOF	Custom	Command Code	Handle	CRC
Frame-Sync	0xE0	0xA6	16 bits	16 bits

Table 16: Tag reply to a successful End Log Command

SOF	Header	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	16 bits	16 bits	Dummy bit [1]

3.8 Start Log Command (0xA7)

The Start Log command starts the logging operation and puts the SL900A into the logging state. This command updates data in the calibration registers, enables the RTC, writes the Start time in UTC

format, starts the Shelf Life Algorithm and sets the Active bit in the System Status field in the EEPROM.

In the logging state the chips automatically performs the sensor measurements in the specified time intervals. Supported is also a delayed start after it receives the Start Log command. Start Log also starts the Interrupt mode in which measurements and data logging is triggered by external events.

Table 17: Start Log Command (0xA7)

SOF	Custom	Command Code	Start Time	Handle	CRC
Frame-Sync	0xE0	0xA7	32 bits	16 bits	16 bits

Start Time

- Bit 5:0 Second
- Bit 11:6 Minute
- Bit 16:12 Hour
- Bit 21:17 Day
- Bit 25:22 Month
- Bit 31:26 Year

Table 18: Tag reply to a successful Start Log Command

SOF	Header	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	16 bits	16 bits	Dummy bit [1]

3.9 Get Log State Command (0xA8)

The Get Lot State command returns the log state relevant parameters such as the measurement status or out of limits counter. This allows ability to quickly check the state of the IC without the need to read the whole temperature data log.

Table 19: Get Log State Command (0xA8)

SOF	Custom	Command Code	Handle	CRC
Frame-Sync	0xE0	0xA8	16 bits	16 bits

Table 20: Tag reply to a successful Get Log State Command

SOF	Header	Limit Counter	System Status	SL-Block 0&1	Current Shelf Life	Status Flag	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	32 bits	32 bits	64 bits	24 bits	8 bits	16 bits	16 bits	Dummy bit [1]
				Optional – only when Shelf Life flag is set in the EEPROM					

Limit Counter:

- Bits 7:0 Extreme Upper Limit
- Bits 15:8 Upper Limit
- Bits 23:16 Lower Limit
- Bits 31:24 Extrem Lower Limit

System Status:

- Bit 0 Active
- Bits 15:1 Number of measurements
- Bits 21:16 Number of memory replacements
- Bits 31:22 Measurements address pointer

Current Shelf Life:

The remaining shelf life is a 24-bit word. When the shelf life reaches 0, the chip can generate a signal on the EXC pin that can be used as an interrupt source. The remaining shelf life can be read from the SPI interface with the 0x08 SPI command.

SL Block 0:

- Bits 7:0 Ea: Activation energy
- Bits 15:8 Tstd: Normal temperature
- Bits 23:16 Tmin: Minimum temperature for the product
- Bits 31:24 Tmax: Maximum temperature for the product

SL Block 1:

- Bits 1:0 RFU
- Bit 2 Shelf life algorithm enable
- Bit 3 Enable negative shelf life
- Bits 5:4 Shelf life sensor ID (temperature, external 1 or external 2)
- Bits 15:6 Tinit: Initial temperature used in the shelf life calculation
- Bits 31:16 SLinit: Initial shelf life

Status Flags:

- Bit 0 Shelf life expired
- Bit 1 Shelf life high error
- Bit 2 Shelf life low error
- Bit 3 Low Battery
- Bit 4 AD error
- Bit 5 Measurement Overwritten
- Bit 6 Measurement area full
- Bit 7 Active (logging operation)

3.10 Get Calibration Data Command (0xA9)

The Get Calibration Data command returns the calibration data field for the internal and external sensors and returns the SFE parameters.

Table 21: Get Calibration Data Command (0xA9)

SOF	Custom	Command Code	Handle	CRC
Frame-Sync	0xE0	0xA9	16 bits	16 bits

Table 22: Tag reply to a successful Get Calibration Data Command

SOF	Header	Calibration Data and SFE Parameters	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	72 bits	16 bits	16 bits	Dummy bit [1]

Calibration Data and SFE Parameters:

- Bit 1:0 Verify Sensor ID:
  - [0,0]: first selected sensor
  - [0,1]: second selected sensor
  - [1,0]: third selected sensor
  - [1,1]: fourth selected sensor
- Bit 2 Auto- Range Disable
- Bit 3 SEXT2:
  - [0]: linear conductive sensor
  - [1]: high impedance input (voltage follower), bridge
- Bits 5:4 SEXT1:
  - [0,0]: linear resistive sensor
  - [0,1]: high impedance input (voltage follower), bridge
  - [1,0]: RFU
  - [1,1]: capacitive or resistive sensor without DC (AC signal on EXC pin)

- Bits 10:6 Seti: External sensor 1 range (current source value).
- Bits 15:11 Rang: External sensor 2 range (resistor feedback ladder).
- Bit 17:16 RFU
- Bit 18 exc_res: Excitation for resistive sensors without DC
- Bits 22:19 reftc: Bandgap voltage temperature coefficient
- Bits 29:23 off_int: Temp. conversion offset calibration
- Bits 34:30 ring_cal: Main system clock oscillator calibration
- Bits 36:35 irlev: Voltage interrupt level for external sensors – ratiometric
- Bits 38:37 selp22: POR voltage level for a 3V system
- Bit 39 sw_ext_en: Controlled battery supply for external sensors – the battery voltage is connected to the EXC pin
- Bits 47:40 df: RTC oscillator calibration
- Bits 52:48 adf: Main reference voltage calibration
- Bits 54:53 selp12: POR voltage level for a 1.5V system
- Bit 55 gnd_switch: Lower AD reference voltage to GND (default. = 1)
- Bits 58:56 coarse2: **Vo2** adjustment
- Bits 63:59 ad2: Higher AD reference voltage – fine
- Bits 66:64 coarse1: **Vo1** adjustment
- Bits 71:67 ad1: Lower AD reference voltage – fine

3.11 Get Battery Level Command (0xAA)

The Get Battery Level command starts the AD conversion on the battery voltage and returns the battery voltage level with the battery type (1.5V or 3V). The application can also request the battery type re-check if the Battery retrigger field has the value “00000001”, otherwise the Battery retrigger field needs to have the value “00000000”.

Table 23: Get Battery Level Command (0xAA)

SOF	Custom	Command Code	Battery Retrigger	Handle	CRC
Frame-Sync	0xE0	0xAA	8 bits	16 bits	16 bits

Table 24: Tag reply to a successful Get Battery Level Command

SOF	Header	AD Error	Battery Type	Zeros	Battery Level	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	1 bit – error [1]	1 bit	4 bits	10 bits	16 bits	16 bits	Dummy bit [1]

Battery Type:

- [0]: 1.5V Battery
- [1]: 3V Battery

Battery Level (U) Conversion:

For the default reference voltage settings Vo1 = 0V and Vo2 = 310mV the battery voltage can be calculated as shown below:

$$U[V] = Code * LSB + Offset$$

while: $LSB = 0.85mV$ @ 1.5V Battery

$LSB = 1.65mV$ @ 3V Battery

and $Offset = 873mV$ @ 1.5V Battery

$Offset = 1.69mV$@ 3V Battery

3.12 Set Shelf Life Command (0xAB)

The Set Shelf Life command defines parameters for the dynamic shelf life algorithm.

Table 25: Set Shelf Life Command (0xAB)

SOF	Custom	Command Code	SL Block 0	SL Block 1	Handle	CRC
Frame-Sync	0xE0	0xAB	32 bits	32 bits	16 bits	16 bits

SL Block 0:

- Bits 7:0 Ea: Activation energy
- Bits 15:8 Tstd: Normal temperature
- Bits 23:16 Tmin: Minimum temperature for the product
- Bits 31:24 Tmax: Maximum temperature for the product

SL Block 1:

- Bits 1:0 RFU
- Bit 2 Shelf life algorithm enable
- Bit 3 Enable negative shelf life
- Bits 5:4 Shelf life sensor ID (temperature, external 1 or external 2)
- Bits 15:6 Tinit: Initial temperature used in the shelf life calculation
- Bits 31:16 SLinit: Initial shelf life

Table 26: Tag reply to a successful Set Shelf Life Command

SOF	Header	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	16 bits	16 bits	Dummy bit [1]

3.13 Initialize Command (0xAC)

The Initialize command resets the System status field, the Limit counters. It sets the Delay time field and the Application data field. The Initialize command is needed before the Start Log command as it will reset the pointers and counters. If the application needs to continue the logging operation from existing log data, the Initialize command can be left out.

Table 27: Initialize Command (0xAC)

SOF	Custom	Command Code	Delay Time	Application Data	Handle	CRC
Frame-Sync	0xE0	0xAC	16 bits	16 bits	16 bits	16 bits

Delay Time:

- Bit 0 IRQ + timer enable
- Bit 1 Delay Mode:
  - [0]: Timer
  - [1]: External switch
- Bits 3:2 RFU
- Bits 15:4 Delay Time

Application Data:

- Bits 2:0 Broken word pointer
- Bits 6:3 RFU
- Bits 15:7 Number of words for application data

Table 28: Tag reply to a successful Initialize Command

SOF	Header	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	16 bits	16 bits	Dummy bit [1]

3.14 Get Sensor Value Command (0xAD)

The Get Sensor Value command starts the AD conversion on the specified sensor and returns the value.

Table 29: Get Sensor Value Command (0xAD)

SOF	Custom	Command Code	Sensor Type	Handle	CRC
Frame-Sync	0xE0	0xAD	8 bits	16 bits	16 bits

Table 30: Tag reply to a successful Get Sensor Value Command

SOF	Header	AD Error	Range / Limit	Sensor Value	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	1 bit – error [1]	5 bits Range – for external sensors Limit current for self-heating compensation	10 bits	16 bits	16 bits	Dummy bit [1]

Sensor Value:

- Bits 1:0 Sensor Type:
  - [0,0]: Temperature Sensor
  - [0,1]: External sensor 1
  - [1,0]: External sensor 2
  - [1,1]: Battery voltage
- Bits 7:2 RFU

3.15 Open Area Command (0xAE)

The End Log command stops the logging operation and turns the real time clock off. It also clears the Active flag in the System Status field in the EEPROM. The IC is left in the passive (standby) mode.

Table 31: Open Area Command (0xA6)

SOF	Custom	Command Code	Password Level	Password	Handle	CRC
Frame-Sync	0xE0	0xAE	8 bits	32 bits	16 bits	16 bits

Password Level:

- Bit 1:0 Security Level:
  - [0,0]: Not allowed.
  - [0,1]: Level 1 – System Memory Area
  - [1,0]: Level 2 – User Memory Area
  - [1,1]: Level 3 – Measurement Memory Area
- Bit 7:2 All zeros

Table 32: Tag reply to a successful Open Area Command

SOF	Header	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	16 bits	16 bits	Dummy bit [1]

3.16 Access FIFO Command (0xAF)

The End Log command stops the logging operation and turns the real time clock off. It also clears the Active flag in the System Status field in the EEPROM. The IC is left in the passive (standby) mode.

Table 33: Access FIFO Command (0xA6)

SOF	Custom	Command Code	Sub-Command	Payload	Handle	CRC
Frame-Sync	0xE0	0xAF	8 bits	0…8 bits	16 bits	16 bits

Sub Command:

- Bits 3:0 Number of bytes to be read from FIFO or written to the FIFO.
- Bit 4 RFU
- Bits 7:5 Sub-Command bits:
  - [1,0,0]: Read data from FIFO
  - [1,0,1]: Write data to the FIFO
  - [1,1,0]: Read the FIFO Status Register
  - All other combinations: RFU

FIFO Status Register:

- Bits 3:0 Number of valid bytes in the FIFO register
- Bit 4 Data source:
  - [0]: Data from SPI
  - [1]: Data from RFID
- Bit 5 No data
- Bit 6 Data ready
- Bit 7 FIFO busy

Access FIFO Command Example:

This example command will write 5 bytes to the FIFO:

Frame Sync + E0 AF A5 11 22 33 44 55 + Handle + CRC

Table 34: Tag reply to a successful Access FIFO Command

SOF	Header	Payload	Handle	CRC	EOF
Pilot tone + Preamble	1 bit [0]	0…8 bits	16 bits	16 bits	Dummy bit [1]

3.17 Error Codes

Table 35: Error Codes

Error Code	Error Name	Error Description	Condition
0x00	Other error	Unspecified Error	
0x03	Memory overrun	The specified memory location does not exist or the EPC length field is not supported by the tag	The EBV address lies outside the physical address of the EEPROM or outside the specified memory bank.
0x04	Memory locked	The specified memory location is locked and/or permalocked and cannot be read or written.	The lock bit for the specified memory bank or a password is set.
0x0B	Insufficient power	The tag has insufficient power to perform the memory write operation.	This error code can only be set in fully passive mode when the supply voltage is too low.
0xA0	Incorrect password	The password is incorrect – tag is not open.	The ams custom password protection is active.
0xA2	Battery measurement	The battery measurement cannot be started.	The tag is fully passive and there is no battery attached.
0xA3	Command not allowed	Command is not allowed in active state.	Custom commands that can modify logging and calibration parameters are not allowed when the tag is in active state (RTC running).
0xA6	EEPROM busy error	The memory cannot be accessed as the measurement unit or SPI is accessing the EEPROM.	This error is reported when the EEPROM is used by the SPI or measurement unit.

4 Contact Information

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Headquarters
ams AG
Tobelbaderstrasse 30
8141 Unterpremstaetten
Austria, Europe

Tel: +43 (0) 3136 500 0
Website: www.ams.com

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6 Revision Information

Changes from 1-00 (2013-Apr-19) to current revision 1-06 (2014-Jul-23)		Page
1-01	Corrections (2013-Nov-25)	
1-02	Corrections (2013-Dec-09)	
1-03	Corrections – Get Calibration Data Command (20130-Dec-13)	16
1-04	Corrections (2014-Feb-02)	
1-05	Added offset calibration information (2014-Mar-05)	
1-06	Update to corporate format	1-24

Note: Page numbers for the previous version may differ from page numbers in the current revision.