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| Document Revision<br>V1.0  | Part Number<br>XXXXXX-XXX                          |  |

# 智能钥匙低频高频通信帧定义


## KeyFob LF-RF Telegram Definition

Version: 1.0

|          | 负责人       | 签名 | 时间 |
|----------|-----------|----|----|
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发布: 上海纳恩汽车技术有限公司

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## Change History


**Table 1.** *Change History*

| Revision | Date      | Change Description | Updated By |
|----------|-----------|--------------------|------------|
| V1.0     | 2013-5-31 | Draft              | Eric Zhou  |
|          |           |                    |            |
|          |           |                    |            |

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## Glossary

| UID  | User ID Device                     |
|------|------------------------------------|
| LF   | Low Frequency                      |
| UHF  | Ultra High Frequency               |
| RSSI | Received Signal Strength Indicator |
| EOL  | End of Line                        |
| RKE  | Remote Keyless Entry               |
| PEPS | Passive Entry Passive Start        |
| IDE  | Identifier                         |
| TBD  | To Be Define                       |
|      |                                    |
|      |                                    |
|      |                                    |


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# 1 Introduction

## 1.1 General

## 1.2 Document Scope

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## 2 RKE Function

### 2.1 Long RKE Telegram

|                        |                 |        |
|------------------------|-----------------|--------|
| Preamble ('111111...') | Start bit ('0') | ID     |
| 104 bits               | 1 bit           | 7 bits |

| UID number | Function Code | IDE   |       |       |       | Battery Status | Button Code |
|------------|---------------|-------|-------|-------|-------|----------------|-------------|
| 4 bits     | 4 bits        | IDE0  | IDE1  | IDE2  | IDE3  |                |             |
| Byte1      |               | Byte2 | Byte3 | Byte4 | Byte5 | Byte6          |             |

| SI-Counter  |             |            |           |          |
|-------------|-------------|------------|-----------|----------|
| SI[27...20] | SI[19...12] | SI[11...4] | SI[3...0] | Reserved |
| Byte7       | Byte8       | Byte9      | Byte10    |          |

| Sequence Response |        |        |        | CRC8   |
|-------------------|--------|--------|--------|--------|
| SR1               | SR2    | SR3    | SR4    |        |
| Byte11            | Byte12 | Byte13 | Byte14 | Byte15 |

|            |
|------------|
| Extra Byte |
| 8 bits     |


✧ Frame Transmit time:  $(104 + 1 + 7 + 15 \times 8 + 8) \text{ bits} / (2000) \text{ bps} = 240 / 2000 = 120 \text{ ms}$

✧ Function Code (4 bits) : 0001b (Long RKE Telegram)

✧ UID Number (4 bits) :  
 UID 1 = 0001b  
 UID 2 = 0010b  
 UID 3 = 0011b  
 UID 4 = 0100b

( Remark: Max number 4 UIDs are supported. )

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✧ IDE: Serial number of UID. (Factory programmed in PCF7952 EEPROM Page0.)

✧ Battery Status (4 bits) :

| VST3 | VST2 | VST1 | VST0 | V <sub>BAT</sub> [V] (typ) |
|------|------|------|------|----------------------------|
| 0    | 0    | 0    | 0    | 1.90                       |
| 0    | 0    | 0    | 1    | 1.99                       |
| 0    | 0    | 1    | 0    | 2.08                       |
| 0    | 0    | 1    | 1    | 2.17                       |
| 0    | 1    | 0    | 0    | 2.26                       |
| 0    | 1    | 0    | 1    | 2.35                       |
| 0    | 1    | 1    | 0    | 2.44                       |
| 0    | 1    | 1    | 1    | 2.53                       |
| 1    | 0    | 0    | 0    | 2.62                       |
| 1    | 0    | 0    | 1    | 2.71                       |
| 1    | 0    | 1    | 0    | 2.80                       |
| 1    | 0    | 1    | 1    | 2.89                       |
| 1    | 1    | 0    | 0    | 2.98                       |
| 1    | 1    | 0    | 1    | 3.07                       |
| 1    | 1    | 1    | 0    | 3.16                       |
| 1    | 1    | 1    | 1    | 3.25                       |

Figure 2.1 Battery Status

✧ Button Code (4 bits) :

0h = free

1h = Lock

2h = Trunk Release


4h = Unlock

✧ SI-Counter: SI-Counter + Button Code 4: 00 00 00 02 + 4 => 00 00 00 24

✧ Sequence Response: HitagII encrypted data

✧ CRC8: 8 bits, CRC8, Polynomial (format:  $x^8+x^2+x+1$ ), Start value 0x00; CRC calculation start from Byte1 toByte14.

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## 2.2 Short RKE Telegram

|                     |                 |        |
|---------------------|-----------------|--------|
| Preamble ('111...') | Start bit ('0') | ID     |
| 10 bits             | 1 bit           | 7 bits |

| UID number | Function Code | IDE   |       |       |       | Battery Status | Button Code |
|------------|---------------|-------|-------|-------|-------|----------------|-------------|
| 4 bits     | 4 bits        | IDE0  | IDE1  | IDE2  | IDE3  |                |             |
| Byte1      |               | Byte2 | Byte3 | Byte4 | Byte5 | Byte6          |             |

|            |
|------------|
| Extra Byte |
| 8 bits     |

✧ Frame Transmit time:  $(8 + 6 + 6 + 6 \times 8 + 8) \text{ bits} / (2000) \text{ bps} = 74 / 2000 = 37 \text{ ms}$

✧ Function Code (4 bits) : 2h = 0002b (Short RKE Telegram)


✧ Button Code (4 bits) :

0h = free  
1h = Lock  
2h = Trunk Release  
4h = Unlock  
8h = Reserved

✧ Other data is the same as Long RKE Telegram.

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### 3 PEPS Function

#### 3.1 PEPS Authentication Command

##### 3.1.1 LF Challenge Message

| Preamble | SYNC   | WUPB   |        |        |        |
|----------|--------|--------|--------|--------|--------|
|          |        | WUP1   | WUP2   | WUP3   | WUP4_a |
| 8 bits   | 9 bits | 8 bits | 8 bits | 8 bits | 8 bits |

| Zone and Trigger Info | LF Command | UID Response Sequence | Random Number |       |       |       |
|-----------------------|------------|-----------------------|---------------|-------|-------|-------|
| 4 bits                | 4 bits     | Max number = 4        | Ran1          | Ran 2 | Ran 3 | Ran 4 |
| Byte1                 |            | Byte2                 | Byte3         | Byte4 | Byte5 | Byte6 |

| MAC   |       | CRC8  |
|-------|-------|-------|
| MAC1  | MAC2  |       |
| Byte7 | Byte8 | Byte9 |

- ✧ WUP: 32 Bits, Wake Up ID, All UIDs of one vehicle must have the same value.

$$WUP4\_a[7...0] = (WUP4[7...0] \ll 4) \mid 0x0F;$$

(Remark: **Each vehicle must have a UNIQUE Vehicle-ID(VID) data as WUP!** It can be one of the UIDs' IDE or the last 4 bytes VIN code. )


- ✧ LF Command (4 bits) : 01h = 0001b

- ✧ Zone and Trigger Info : (TBD)

Passive Entry = 01h;  
 Passive Start = 02h;  
 Passive Exit = 03h;  
 Passive Trunk Close = 04h;

- ✧ UID Response Sequence : Max 4 UIDs are supported.

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| UID Response Sequence |      |      |      |      |      |       |      |
|-----------------------|------|------|------|------|------|-------|------|
| UID4                  |      | UID3 |      | UID2 |      | UID 1 |      |
| Bit7                  | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1  | Bit0 |
| 1                     | 1    | 1    | 0    | 0    | 0    | 0     | 1    |

The UID Response Sequence is: 0->1->2->3 = UID2->UID1->UID3->UID4

- ✧ Random Number: 32 bits Random Number Generated by PEPS Module.
- ✧ MAC: 16 Bits Message Authentication Code, intermediate result of Hitag3 algorithm
- ✧ CRC8: 8 bits, CRC8, Polynomial (format:  $x^8+x^2+x+1$ ), Start value 0x00; CRC calculation start from Byte1 to Byte8.

### 3.1.2 UHF Response Message

|                     |                 |        |
|---------------------|-----------------|--------|
| Preamble ('111...') | Start bit ('0') | ID     |
| 10 bits             | 1 bit           | 7 bits |


| UID number | Function Code | Battery Status | UID Info | Response |       |       |       |       |       |
|------------|---------------|----------------|----------|----------|-------|-------|-------|-------|-------|
| 4 bits     | 4 bits        |                |          | RESP1    | RESP2 | RESP3 | RESP4 | RESP5 | RESP6 |
| Byte1      |               | Byte2          |          | Byte3    | Byte4 | Byte5 | Byte6 | Byte7 | Byte8 |

| LF RSSI Value |        |        |        |        |        | CRC8   |
|---------------|--------|--------|--------|--------|--------|--------|
| Mant1         | Exp1   | Mant2  | Exp2   | Mant3  | Exp3   |        |
| Byte9         | Byte10 | Byte11 | Byte12 | Byte13 | Byte14 | Byte15 |

|            |
|------------|
| Extra Byte |
| 8 bits     |

- ✧ Function Code: 4 Bits, 03h = 0011b, PEPS Authentication Response

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- ✧ UID Number: 4 Bits,      UID1 = 0001b  
  UID 2 = 0010b  
  UID 3 = 0011b  
  UID 4 = 0100b
- ✧ UID Info: 4 Bits, Reserved
- ✧ Battery Status: 4 Bits, See .
- ✧ Response: 48 Bits Message Authentication Code, result of Hitag3 algorithm
- ✧ LF RSSI Value: for 3 antenna, each 2 Byte (exponent and mantissa)
- ✧ CRC8: 8 bits, CRC8, Polynomial (format:  $x^8+x^2+x+1$ ), Start value 0x00; CRC calculation start from Byte1 to Byte14.

## 3.2 PEPS Fob Search Command(TBD)


### 3.2.1 LF Challenge Message

| Preamble | SYNC   | WUPB   |        |        |               |
|----------|--------|--------|--------|--------|---------------|
|          |        | WUP1   | WUP2   | WUP3   | <b>WUP4_a</b> |
| 8 bits   | 9 bits | 8 bits | 8 bits | 8 bits | 8 bits        |

| Zone and Trigger Info | LF Command | UID Response Sequence |
|-----------------------|------------|-----------------------|
| 4 bits                | 4 bits     | Max number = 4        |
| Byte1                 |            | Byte2                 |

- ✧ LF Command (4 bits) : 02h = 0002b
- ✧ Zone and Trigger Info : (TBD)  
Passive Entry = 01h;

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Passive Start = 02h;  
 Passive Exit = 03h;  
 Passive Trunk Close = 04h;

✧ UID Response Sequence : Max 4 UIDs are supported.

| UID Response Sequence |      |      |      |      |      |       |      |
|-----------------------|------|------|------|------|------|-------|------|
| UID4                  |      | UID3 |      | UID2 |      | UID 1 |      |
| Bit7                  | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1  | Bit0 |
| 1                     | 1    | 1    | 0    | 0    | 0    | 0     | 1    |

The UID Response Sequence is: 0->1->2->3 = UID2->UID1->UID3->UID4

### 3.2.2 UHF Response Message

|                     |                 |        |
|---------------------|-----------------|--------|
| Preamble ('111...') | Start bit ('0') | ID     |
| 10 bits             | 1 bit           | 7 bits |


| UID number | Function Code | IDE   |       |       |       |
|------------|---------------|-------|-------|-------|-------|
| 4 bits     | 4 bits        | IDE0  | IDE1  | IDE2  | IDE3  |
| Byte1      |               | Byte2 | Byte3 | Byte4 | Byte5 |

|            |
|------------|
| Extra Byte |
| 8 bits     |

✧ Function Code: 4 Bits, 0Ah = 1010b

✧ UID Number: 4 Bits,  
     UID1 = 0001b  
     UID 2 = 0010b  
     UID 3 = 0011b  
     UID 4 = 0100b

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### 3.3 PEPS EOL Login

#### 3.3.1 LF Challenge Message

| Preamble | SYNC   | WUPA   |        |        |               |
|----------|--------|--------|--------|--------|---------------|
|          |        | WUP1   | WUP2   | WUP3   | <b>WUP4_a</b> |
| 8 bits   | 9 bits | 8 bits | 8 bits | 8 bits | 8 bits        |

| Reserved | LF Command | Login ID |        |        |        |
|----------|------------|----------|--------|--------|--------|
| 4 bits   | 4 bits     | LID 0    | LID1 1 | LID1 2 | LID1 3 |
| Byte1    |            | Byte2    | Byte3  | Byte4  | Byte5  |

| Reserved |       | CRC8  |
|----------|-------|-------|
| 1        | 2     |       |
| Byte6    | Byte7 | Byte8 |

- ✧ WUPA: 32 Bits, Wake Up ID for EOL, different with the Authentication command.

Default value = 0x20 0x16 0x12 0xEF, saved in EEPROM;

**$WUP4\_a[7...0] = (WUP4[7...0] \ll 4) \mid 0x0F;$**


- ✧ LF Command (4 bits) : 03h = 0003b

- ✧ Login ID (4 bytes) : default value = 0xAB 0x52 0x34 0xEF, saved in EEPROM;

#### 3.3.2 UHF Response Message

| Preamble ('111...') | Start bit ('0') | ID     |
|---------------------|-----------------|--------|
| 10 bits             | 1 bit           | 7 bits |

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| UID number | Function Code | VID   |       |       |       |
|------------|---------------|-------|-------|-------|-------|
| 4 bits     | 4 bits        | VID 0 | VID 1 | VID 2 | VID 3 |
| Byte1      |               | Byte2 | Byte3 | Byte4 | Byte5 |

| IDE   |       |       |       | Battery Status | Reserved | CRC8   |
|-------|-------|-------|-------|----------------|----------|--------|
| IDE0  | IDE1  | IDE2  | IDE3  | 4 bits         | 4 bits   |        |
| Byte6 | Byte7 | Byte8 | Byte9 | Byte10         |          | Byte11 |


|            |
|------------|
| Extra Byte |
| 8 bits     |

✧ Function Code: 4 Bits, 04h

✧ UID Number: 4 Bits,      UID1 = 0001b  
                                       UID 2 = 0010b  
                                       UID 3 = 0011b  
                                       UID 4 = 0100b

✧ Battery Status: 4 Bits .

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| VST3 | VST2 | VST1 | VST0 | V <sub>BAT</sub> [V] (typ) |
|------|------|------|------|----------------------------|
| 0    | 0    | 0    | 0    | 1.90                       |
| 0    | 0    | 0    | 1    | 1.99                       |
| 0    | 0    | 1    | 0    | 2.08                       |
| 0    | 0    | 1    | 1    | 2.17                       |
| 0    | 1    | 0    | 0    | 2.26                       |
| 0    | 1    | 0    | 1    | 2.35                       |
| 0    | 1    | 1    | 0    | 2.44                       |
| 0    | 1    | 1    | 1    | 2.53                       |
| 1    | 0    | 0    | 0    | 2.62                       |
| 1    | 0    | 0    | 1    | 2.71                       |
| 1    | 0    | 1    | 0    | 2.80                       |
| 1    | 0    | 1    | 1    | 2.89                       |
| 1    | 1    | 0    | 0    | 2.98                       |
| 1    | 1    | 0    | 1    | 3.07                       |
| 1    | 1    | 1    | 0    | 3.16                       |
| 1    | 1    | 1    | 1    | 3.25                       |

Figure 3.1 Battery Status

### 3.4 PEPS RSSI Calibration


#### 3.4.1 LF Challenge Message

| Preamble | SYNC   | WUPA   |        |        |        |
|----------|--------|--------|--------|--------|--------|
|          |        | WUP1   | WUP2   | WUP3   | WUP4_a |
| 8 bits   | 9 bits | 8 bits | 8 bits | 8 bits | 8 bits |

|            |          |          |          |          |          |
|------------|----------|----------|----------|----------|----------|
| LF Command | Reserved | Reserved | Reserved | Reserved | Reserved |
| 8 bits     |          |          |          |          |          |
| Byte1      | Byte2    | Byte3    | Byte4    | Byte5    | Byte6    |

|      |            |
|------|------------|
| CRC8 | LF Carrier |
|      |            |

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|       |      |
|-------|------|
| Byte7 | 15ms |
|-------|------|

- ✧ WUP: 32 Bits, **WUPA**, Wake Up ID for EOL.  $WUP4\_a[7...0] = (WUP4[7...0] \ll 4) \mid 0x0F$ ; the default data : 0x20 0x16 0x12 0xEF
- ✧ LF Command (4 bits) : 0Ah = **1010b**
- ✧ CRC8: 8 bits, CRC8, Polynomial (format:  $x^8+x^2+x+1$ ), Start value 0x00; CRC calculation start from Byte1 to Byte6.

### 3.4.2 UHF Response Message

| Reserved | Function Code | Gain Range x | Gain Range y | Gain Range z | RSSI x |       |       |
|----------|---------------|--------------|--------------|--------------|--------|-------|-------|
| 4 bits   | 4 bits        |              |              |              | Mant1  | Mant2 | Exp   |
| Byte1    |               | Byte2        | Byte3        | Byte4        | Byte5  | Byte6 | Byte7 |

| RSSI y |       |        | RSSI z |        |        | Reserved | Reserved | CRC8   |
|--------|-------|--------|--------|--------|--------|----------|----------|--------|
| Mant1  | Mant2 | Exp    | Mant1  | Mant2  | Exp    |          |          |        |
| Byte8  | Byte9 | Byte10 | Byte11 | Byte12 | Byte13 | Byte14   | Byte15   | Byte16 |

- ✧ Function Code: 4 Bits, 05h = **0101b**,
- ✧ RSSI x/y/z: floating point data,  $= (RSSI_{adc} - Offset) * GAIN_{range}$
- ✧ CRC8: 8 bits, CRC8, Polynomial (format:  $x^8+x^2+x+1$ ), Start value 0x00; CRC calculation start from Byte1 to Byte15.

## 3.5 PEPS Write EEPROM


### 3.5.1 LF Challenge Message

| Preamble | SYNC   | WUPA   |        |        |               |
|----------|--------|--------|--------|--------|---------------|
|          |        | WUP1   | WUP2   | WUP3   | <b>WUP4_a</b> |
| 8 bits   | 9 bits | 8 bits | 8 bits | 8 bits | 8 bits        |

- ✧ LF Command (4 bits) : 0Bh

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### 3.5.2 UHF Response Message

✧ Function Code: 4 Bits, 06h

## 3.6 PEPS Read EEPROM

### 3.6.1 LF Challenge Message

| Preamble | SYNC   | WUPA   |        |        |               |
|----------|--------|--------|--------|--------|---------------|
|          |        | WUP1   | WUP2   | WUP3   | <b>WUP4_a</b> |
| 8 bits   | 9 bits | 8 bits | 8 bits | 8 bits | 8 bits        |

✧ LF Command (4 bits) : 0Ch

### 3.6.2 UHF Response Message

✧ Function Code: 4 Bits, 07h


## 3.7 PEPS Calculate Input Voltage out of RSSI Results

### 3.7.1 LF Challenge Message

| Preamble | SYNC   | WUPA   |        |        |               |
|----------|--------|--------|--------|--------|---------------|
|          |        | WUP1   | WUP2   | WUP3   | <b>WUP4_a</b> |
| 8 bits   | 9 bits | 8 bits | 8 bits | 8 bits | 8 bits        |

|            |          |          |          |          |          |
|------------|----------|----------|----------|----------|----------|
| LF Command | Reserved | Reserved | Reserved | Reserved | Reserved |
| 8 bits     |          |          |          |          |          |
| Byte1      | Byte2    | Byte3    | Byte4    | Byte5    | Byte6    |

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|       |            |
|-------|------------|
| CRC8  | LF Carrier |
|       |            |
| Byte7 | 15ms       |

- ✧ WUP: 32 Bits, **WUPA**, Wake Up ID for EOL.  **$WUP4\_a[7...0] = (WUP4[7...0] \ll 4) \mid 0x0F$** ; the default data : 0x20 0x16 0x12 0xEF
- ✧ LF Command (4 bits) : **0Dh**
- ✧ CRC8: 8 bits, CRC8, Polynomial (format:  $x^8+x^2+x+1$ ), Start value 0x00; CRC calculation start from Byte1 to Byte6.

### 3.7.2 UHF Response Message

| Reserved | Function Code | Gain Range | RSSI ADC measurement |       | RSSI ADC Offset |       |
|----------|---------------|------------|----------------------|-------|-----------------|-------|
| 4 bits   | 4 bits        |            | ADCL                 | ADCH  | ADCL            | ADCH  |
| Byte1    |               | Byte2      | Byte3                | Byte4 | Byte5           | Byte6 |


| RSSI convert |       |       | Reserved | Reserved | Reserved | Reserved | CRC8   |
|--------------|-------|-------|----------|----------|----------|----------|--------|
| Mant1        | Mant2 | Exp   |          |          |          |          |        |
| Byte7        | Byte8 | Byte9 | Byte10   | Byte11   | Byte12   | Byte13   | Byte14 |

- ✧ Function Code: 4 Bits, 08h = **1000b**,
- ✧ RSSI ADC measurement: **RSSIadc**, 12bit resolution
- ✧ RSSI ADC Offset: **Offset** , 12bit resolution
- ✧ RSSI convert: floating point data, = (RSSIadc - Offset ) \* GAINrange
- ✧ CRC8: 8 bits, CRC8, Polynomial (format:  $x^8+x^2+x+1$ ), Start value 0x00; CRC calculation start from Byte1 to Byte13.

## 3.8 PEPS RSSI Calibration Verify

### 3.8.1 LF Challenge Message

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| Preamble | SYNC   | WUPA   |        |        |        |
|----------|--------|--------|--------|--------|--------|
|          |        | WUP1   | WUP2   | WUP3   | WUP4_a |
| 8 bits   | 9 bits | 8 bits | 8 bits | 8 bits | 8 bits |

|            |          |          |          |          |          |
|------------|----------|----------|----------|----------|----------|
| LF Command | Reserved | Reserved | Reserved | Reserved | Reserved |
| 8 bits     |          |          |          |          |          |
| Byte1      | Byte2    | Byte3    | Byte4    | Byte5    | Byte6    |

|       |            |
|-------|------------|
| CRC8  | LF Carrier |
|       |            |
| Byte7 | 15ms       |

- ✧ WUP: 32 Bits, **WUPA**, Wake Up ID for EOL.  $WUP4\_a[7...0] = (WUP4[7...0] \ll 4) \mid 0x0F$ ; the default data : 0x20 0x16 0x12 0xEF
- ✧ LF Command (4 bits) : 0Eh
- ✧ CRC8: 8 bits, CRC8, Polynomial (format:  $x^8+x^2+x+1$ ), Start value 0x00; CRC calculation start from Byte1 to Byte6.


### 3.8.2 UHF Response Message

|          |               |              |              |              |          |       |     |
|----------|---------------|--------------|--------------|--------------|----------|-------|-----|
| Reserved | Function Code | Gain Range x | Gain Range y | Gain Range z | RSSI^2 x |       |     |
| 4 bits   | 4 bits        |              |              |              | Mant1    | Mant2 | Exp |
| Byte1    | Byte2         | Byte3        | Byte4        | Byte5        | Byte6    | Byte7 |     |

|            |       |        |               |        |        |          |          |        |
|------------|-------|--------|---------------|--------|--------|----------|----------|--------|
| RSSI^2 x+y |       |        | RSSI ^2 x+y+z |        |        | Reserved | Reserved | CRC8   |
| Mant1      | Mant2 | Exp    | Mant1         | Mant2  | Exp    |          |          |        |
| Byte8      | Byte9 | Byte10 | Byte11        | Byte12 | Byte13 | Byte14   | Byte15   | Byte16 |


- ✧ Function Code: 4 Bits, 09h = 1001b,

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- ✧ RSSI x/y/z: floating point data, = (RSSIadc - Offset ) \*GAINrange
- ✧ CRC8: 8 bits, CRC8, Polynomial (format:  $x^8+x^2+x+1$ ), Start value 0x00; CRC calculation start from Byte1 to Byte15.

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## Appendix

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