# EM BEACON SENSOR

# PACKET SPECIFICATION

## 1.    INTRODUCTION

The following document describes the EM Beacon sensor packet format.

## 2.    PACKET FORMAT

### 2.1    BLUETOOTH LOW-ENERGY REQUIREMENTS

An EM Beacon sensor packet format is the PDU of an advertising channel packet as described in BT core V4.0, Volume 6, Section 2.1.  More specifically, it conforms to the ADV_NONCONN_IND PDU format as described by V4.0 Vol 6 Section 2.3.1.3 from which the Figure 1 graphic is borrowed:
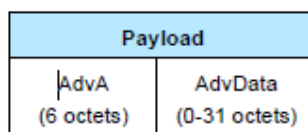


**Figure 1: ADV_NONCONN_INC PDU Payload**

- ✔ The Advertise Address – AdvA - encodes the first six bytes and conforms to the device address
- ✔ The remaining 31 bytes – the AdvData – is comprised of 2 AD Structures, each with its own Length, AD Type, and AD Data as described in Figure 2 from BT Core V4.0 Vol3, Section 11 "Advertising and Scan Response Data Format":
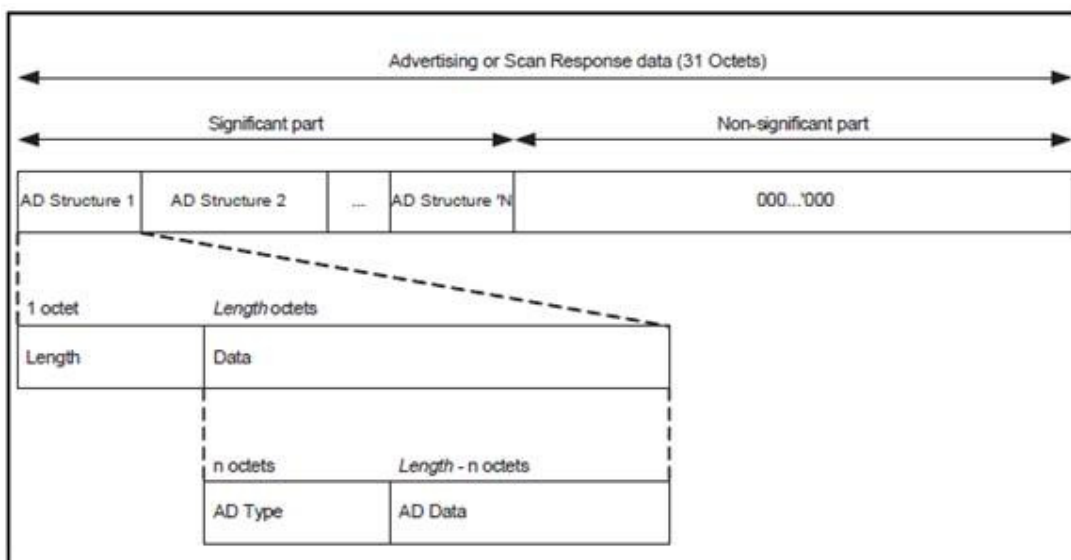


**Figure 2: Advertising and Scan Response Data Format**

*First PDU (Local name)*
✔The length field of the first PDU contains 0x0E (15 bytes).
✔The Type field of the first PDU contains 0x09 (designates the Local Name)
✔The Local Name contains the zero-terminated ASCII text "EM Beacon XYZ".

*Second PDU (Manufacturers specific data)*
✔The length of the second AD Structure is encoded as the value 0x0E (15 bytes).
✔The second AD Type is encoded as 0xFF (the value for Manufacturer Specific Data).
✔……

### 2.2 SENSOR PACKET FORMAT FW PRIOR TO V2.5.0

This section describes the original sensor packet format. The original sensor packet format was used on Tiny and Low-Cost reference designs, as well as prototype versions of the COiN beacon.

The original Sensor PDU format is shown in the Figure 3 below and is 37 bytes long.



**Figure 3: Original Sensor Packet Format**

#### 2.2.1 Local Name
✓The Local Name, contains the zero-terminated ASCII text "EM Beacon *XYZ*".
✓*XYZ* is replaced by the last 3 digits of the EM 6819 serial number. (In the example in Figure 1 *XYZ* = "035".)

#### 2.2.2 The Manufacturers Specific Data
✓Bluetooth Manufacturers Specific Data is used (0xFF) for the following fields.

#### 2.2.3 The Manufacturers ID
✓The Manufacturers ID is encoded with the EM Microelectronic ID from the Bluetooth SIG (90 = 0x005A), low byte first.

#### 2.2.4 Light Sensor Reading
✓The light sensor reading is encoded as two bytes with the light sensor reading in Lux from 0-4095, high byte first, and placed in the ALS field.

#### 2.2.5 Temperature Reading
✓Temperature is encoded in degrees Celsius using 2 bytes as a signed 2's complement number, high byte first, with an implicit decimal point between the first and second bytes.

#### 2.2.6 Battery Voltage
✓The battery voltage is stored as a single byte in binary-coded decimal format (BCD) where the 4 most-significant bits are integer and the 4 least-significant bits are the decimal part. For example, 2.8V = 0x28.

#### 2.2.7 Transmitted Packets
✓The total number of advertisements transmitted since the battery was inserted is represented a 32-bit integer, MSB first.

#### 2.2.8 Button Press
✓The number of times the button is pressed: 2 bytes, MSB first.

### 2.3 SENSOR PACKET FORMAT FW V2.5.0 AND HIGHER

This section describes the new Sensor packet format. This sensor packet is used on the EMBC01 as well as future sensor beacon designs.

The new sensor PDU format is shown in the Figure 4 below and is also 37 bytes long. The Advertise Address is in the first few columns and conforms to the BLE Device Address. The rest of the columns comprise the Advertise Data. The Advertise Data consists of the Local Name, Manufacturers ID and Data, each preceded by the length in bytes.

| AdvAddress | | | AdvData | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EM specific adv address (public), from IEEE | | beacon specific address from 6819 serial number lower 3 bytes | number of bytes to/including end of complete local name | complete local name (18.3) | E | M | B | e | a | c | o | n | unique beacon number derived Minor ID (23035) | | | | | end of complete local name | number of user data bytes to follow | manufactirer specific data, company identifier code | Maufacturer ID (low) | Maufacturer ID (high) | Sensor data (high) | Sensor data (low) | Model Number (ASCII,high) | Model Number (ASCII,low) | Battery Voltage(V) | number of packets transmitted (MSB) | number of packets transmitted | number of packets transmitted | number of packets transmitted (LSB) | Event Count (MSB) | Event Count (LSB) |
| 0C | F3 | EE | S2 | S1 | S0 | 0F | 09 | 45 | 4D | 42 | 65 | 61 | 63 | 6F | 6E | 32 | 33 | 30 | 33 | 35 | 00 | 0E | FF | 5A | 00 | SD | SD | MN | MN | BB | PP | PP | PP | PP | EC | EC |

**Figure 4: New Sensor Packet Format**

### 2.3.1 Local Name
✓ The local name for new beacons is made with the zero-terminated ASCII text: "EMBeacon*ABCDE"*, where *ABCDE* is the same as the Minor ID (including leading zeros).

### 2.3.2 The Manufacturers Specific Data
✓Bluetooth Manufacturers Specific Data is used (0xFF) for the following fields.

### 2.3.3 Manufacturers ID
✓The Manufacturers ID is encoded with the EM Microelectronic ID from the Bluetooth SIG (90 = 0x005A), low byte first.

### 2.3.4 Sensor Reading
✓For new beacons this field is a sensor reading. The highest nibble represents the sensor type, and the lower 3 nibbles represent the sensor data. Sensor types and data format are listed below.

**Table 1: Sensor types and format definition**

| Description | MS-nibble | Data Format |
|---|---|---|
| Light | 0x0 | 12-bit unsigned int le 0-4,095 |
| Firmware Revision | 0x1 | BCD 4msb.4nsb.4lsb ie 2.5.0 |
| Autocal Results | 0x2 | BCD 4msb/8lsb ie 7/35 |
| Generic | 0x3 | 12-bit unsigned int |
| Temperature | 0x4 | 12-bit fixed-point 4 fractional bits 2's compliment le -0.25=0xFFC |
| Pressure | 0x5 | 12-bit unsigned 0hPA=44,330m 300hPa = 9165.2m 1100hPa=-698.4m |
| Humidity | 0x6 | 12-bit fixed-point 4 fractional bits 2's compliment |

| | | | 0.0-100.0% |
|---|---|---|---|
| Time | 0x7 | | BCD: HH:MM (see detail below) Hour = 1-12 Minute = 0-59 |
| Date | 0x8 | | BCD: MM,-,DD (see detail below) Date: 1-31 Month: 1-12 Spell month, ie 1=January |
| Magnetic Field | 0x9 | | 12-bit fixed-point 4 fractional bits 2's compliment Ie +/-1300µT |
| Day | 0xA | | BCD: A/P,DD,YY (see detail below) Spell day, ie 0=January "am" or "pm" |
| Acceleration | 0xB | | 12-bit fixed-point 6 fractional bits 2's compliment Ie +/-16g |
| Gyro | 0xC | | 12-bit signed Ie +/-2000 |
| TBD | 0xD | | |
| TBD | 0xE | | |
| TBD | 0xF | | |

### 2.3.4.1. Time format

- Bit0-3: Minutes unit 0-9
- Bit4-6: Minutes tens: 0-5
- Bit7-10: Hours unit: 0-9
- Bit 11: Hours tens: 0-1

### 2.3.4.2. Date format

- Bit0-3: Date unit 0-9
- Bit4-5: Date tens: 0-3
- Bit 6: unused
- Bit7-10: Month unit: 0-9
- Bit 11: Month tens: 0-1

### 2.3.4.3. Day format

- Bit0-3: Years unit 0-9
- Bit4-6: Years tens 0-7
- Bit7-9: Day 0-7
- Bit10: am = 0, pm = 1
- Bit11: unused

### 2.3.5 Model Number

✓ For new beacons this field is a model number. The 16-bit field is a 2-digit ASCII encoded value. For example, COiNs are encoded as "01" = 0x3031, Tiny beacons are "TY" = 0x5459, and Low-Cost beacons are "LC" = 0x4C43.

### 2.3.6 Battery Voltage

✓ The battery voltage is stored as a single byte in binary-coded decimal format (BCD) where the 4 most-significant bits are integer and the 4 least-significant bits are the decimal part. For example, 2.8V = 0x28.

### 2.3.7 Transmitted Packets

✓ The total number of advertisements transmitted including Sensor and ID packets since the battery was inserted is represented as a 32-bit integer, MSB first.

### 2.3.8 Event Counter

✓For new beacons this field is a generic event counter. The highest nibble represents the event type, and the lower 3 nibbles represent the event count. Event types are listed below.

**Table 2: Event types and format definition**

| Description | MS-nibble |
|---|---|
| Button Press | 0x0 |
| Low Battery | 0x1 |
| VCO Cal | 0x2 |
| Low Temperature | 0x3 |
| High Temperature | 0x4 |
| Low Pressure | 0x5 |
| High Pressure | 0x6 |
| Low Humidity | 0x7 |
| High Humidity | 0x8 |
| Close Magnet | 0x9 |
| Far Magnet | 0xA |
| Any movement | 0xB |
| Tap | 0xC |
| Fall | 0xD |
| Alarm | 0xE |
| Buzzer | 0xF |