# Bluetooth® Low-Energy Proximity Beacon With Accelerometer
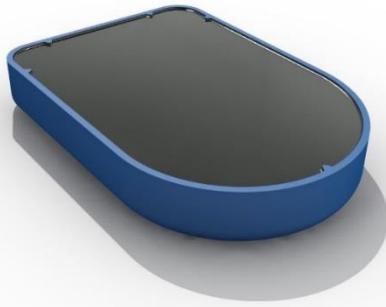
FEATURES

l Small, rugged and encapsulated in polymer resin
l Low-cost and easy to use
l Supports popular beacon formats such as iBeacon™, Eddystone™, AltBeacon™, and proprietary such as Quuppa Intelligent Locating System™
l Unique and scannable QR-code come standard
l Accelerometer can be used to activate beaconing on actions such as movement or gestures
l Secure over-the-air updates possible with all major mobile platforms in the field
l Multiple interleaved packet types with customizable parameters:
　l Packet types, including custom packet types
　l Device name, address, manufacturer name, model number, HW/SW revision
　l UUID, Major/Minor ID, UID or URL
　l Beacon interval, Transmitter power
　l Accelerometer function and sensitivity
l A key benefit of EMBP00 is the extremely rich set of parameters configurable Over the Air which allows it address a very large range of applications without modifying firmware.
l Up to 10 years of battery life, depending on advertisement configuration
　l Battery lifetime calculator available
l Up to 50m range line-of-sight (LOS) at maximum output power
l Weatherproof Enclosure
l Temperature range from -20C to +60C
l Modular Bluetooth V5.0, FCC, IC, and CE certified, RoHS and REACH compliant
l Made with Swatch Electronics Group technologies:
　l EM Microelectronic EM9304 Bluetooth V5.0 SOC
　l Renata CR2032 coin-cell battery

DESCRIPTION

The EMBP00 is a high-performance, customizable Bluetooth V5.0 low energy proximity beacon with an accelerometer for advanced functionality. The small and rugged EMBP00 comes fully encapsulated with a resin based polymer for protection against dust and liquids and reliable use in harsh environmental conditions. The beacon has been optimized for low-cost and ease of use.

The EMBP00 is compatible with major beacon formats including iBeacon™, Eddystone™, AltBeacon™, and trackable with proprietary systems such as the Quuppa Intelligent Locating System™. The beacon is fully customizable over the air or in manufacturing. For example, the following parameters can be easily modified:

- Packet types, including custom packet type
- Device name, address, manufacturer name, model number, HW/SW revision
- UUID, Major/Minor ID, UID or URL
- Beacon interval
- Transmitter output power
- Accelerometer function and sensitivity

The EMBP00 accelerometer can be used to implement efficient and low-energy algorithms for various applications. The accelerometer can be used to activate beaconing on movement, or gestures, for example. When not active, the beacon consumes minimal energy.

The EMBP00 can be stored in Warehouse Mode without significantly degradation the battery lifetime and up to 10 years of battery life depending on usage conditions.

The EMBP00 can be delivered in any quantity with guaranteed unique ID. A 2D unique serial number is printed on the beacon for optical scanning.

The EMBP00 comes is weather resistant and operates over a -20C to +60C temperature range. The EMBP00 is Bluetooth V5.0, FCC, IC, and CE certified, RoHS and REACH compliant.

TABLE OF CONTENTS

1. GENERAL DESCRIPTION

The EMBP00 is a 2.4 GHz RF electronic beacon with proximity capability, compatible with most common beacon standards with a low cost design for mass production, and includes a low-power accelerometer for activation features.

Over-the-air configurable:
- **Up to 10 advertisements running parallel and uniquely defined**
  - Multiple Industry Standard Packet Types
    - iBeacon™
    - altBeacon™
    - Eddystone™ UID, URL and TLM
    - User Defined fixed payload

  - Wide range advertisement interval
    - From 30ms to 18hrs

  - 17 Output Power Steps
    - From +6dBm to -34dBm

  - Activity Gated Advertising Options
    - Continuous Advertising
    - Advertising On Activity
    - Advertising When Not Active

- **Simple state machine**
  - Optional factory enabled event to enter Configuration Mode using a flip motion
  - Optional user enabled event to transition between Warehouse and Beaconing Mode using a flip motion
  - User configurable timeouts from the Configuration and Active Modes
    - From 100ms to 1.8hrs
  - User defined events to activate Activity Mode
    - Motion, tap, double tap, freefall or flip

- **Flexible accelerometer settings**
  - Control of sensitivity, sampling rates, duration, etc. settings

Long Range:
- 30m LOS at 0dBm
- 50m LOS at max output power

Long Battery Life:
- 225mAh CR2032 Li 3V battery
- Up to 10 years storage life

Normal Operating Conditions:
- -20 to +60 C
- Weather proof

Small and Lightweight:
- 32.3 x 22.3 x 5.3 mm outer dimensions
- 7 grams

Certifications:
- Environmental: RoHS, REACH, Halogen Free
- RF: FCC, IC, CE

Compatible With:
- Bluetooth Smart Ready Devices
- Most Common Beacon Standards

EMBC Configuration Tool
- A free smart phone and tablet application for Android to update the operating parameters

Included Hardware:
- A blue plastic enclosure filled with black polymer resin
- A permanent label with a unique serial number and QR Code

Battery Size:
- Standard in EMBP00 housing is CR2032/225mAh battery

Fully Customizable:
- Rich set of modifiable parameters over-the-air.

2. ENVIRONMENTAL AND STORAGE CONDITIONS

The operating and storage conditions are listed in Table 1.

Table 1: Environmental and storage conditions	
Module operating temperature and humidity range	-20°C to 60°C and 0 to 85% RH
Weatherproof	Module can be used in outdoor conditions.
Module storage temperature and humidity range	Modules must be stored in original EM packing at Temp=25°C±5°C / RH 30-45%.

3. PRODUCT OUTLINE DIMENSIONS

3.1. FINISHED PRODUCT

The finished product outline dimensions are shown in Figure 1.
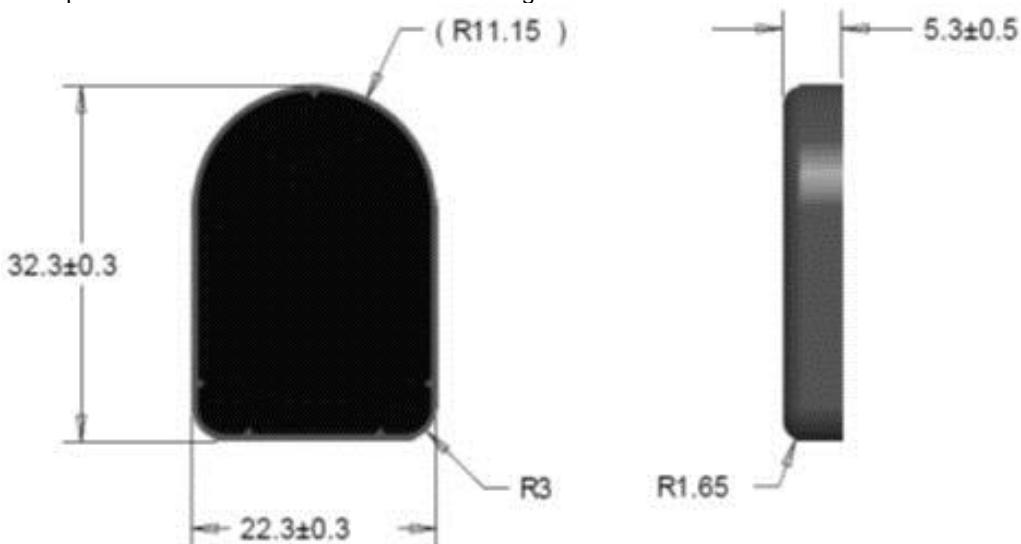
Figure 1: EMBP00 finished product outline dimensions

4. MODELS IN PRODUCT FAMILY

FCC-ID: 2ACQR-EMBP0
IC: 12155A-EMBP0

The FCC and IC identifications above apply to a base product with the model number EMBP01. In this product family we also have EMBP00, EMBP02, and EMBP03. This documents shows the differences between the products and shows the label relevant to each product in the family.

PRODUCT MODELS IN THE FAMILY

PRODUCT MODEL NAME	PCB Variant	BOM Variant	Cup Color
EMBP00	RevA	Full BOM	Teal
EMBP01	RevD Solder mask change from RevC	DNP 1 sensor + 2 passives	Blue
EMBP02	RevC Solder mask change from RevB	DNP 1 sensor + 2 passives + LFXTAL	Red
EMBP03	RevB Minor copper change from RevA in digital section only	Full BOM	Teal

LABELS FOR EACH MODEL IN THE FAMILY (EMBP00 , EMBP01 , EMBP02 , EMBP03)

FCC-ID: 2ACQR-EMBP0
IC: 12155A-EMBP0
Model:EMBP00
SN: 019864239403788

FCC-ID: 2ACQR-EMBP0
IC: 12155A-EMBP0
Model:EMBP01
SN: 019864239403788
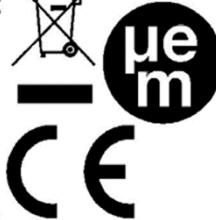
FCC-ID: 2ACQR-EMBP0
IC: 12155A-EMBP0
Model:EMBP02
SN: 019864239403788

FCC-ID: 2ACQR-EMBP0
IC: 12155A-EMBP0
Model:EMBP03
SN: 019864239403788

5. MECHANICAL

5.1. MATERIALS

PA66 Zytel 101E NC010 Blue casing filled with WEVOPUR 552FL with WEVONAT 300.

5.2. ACCELEROMETER

The accelerometer is an LIS2DWL MEMS digital output motion sensor for measuring high-performance ultra-low-power 3-axis "femto" acceleration. The X-Y-Z orientation of the accelerometer are as shown in Figure 2.
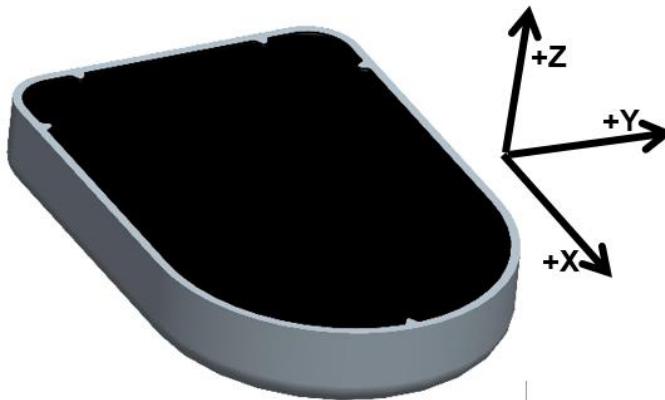
Figure 2: EMBP00 XYZ orientation of the accelerometer in final product

6. ELECTRICAL

Typical values are stated at room temperature (T=25°C) with a supply voltage of VCC=3.0V.

6.1. HANDLING PROCEDURES AND ABSOLUTE MAXIMUM RATINGS

The finished product is compliant with EN 61000-4-2 (Electrostatic Discharge) level 2: 4kV contact discharge and 8kV air discharge.

Stresses above these listed maximum ratings may cause permanent damage to the device. Exposure beyond specified operating conditions may affect device reliability or cause malfunction

6.2. GENERAL OPERATING CONDITIONS

The general operating conditions are listed in Table 2.

Table 2: General Operating Conditions				
Parameter	Min	Typ	Max	Unit
Supply Voltage (VCC)	2.0	3.0	3.6	V
Temperature Range	-20	25	+60	°C
Humidity Range	0	25	85	RH

6.3. ELECTRICAL CHARACTERISTICS

The electrical characteristics are given in Table 3 for a typical use case. A battery lifetime calculator is available to estimate battery the battery lifetime with alternate configurations.

Unless otherwise specified: VCC=3.0V, T=25°C.

Table 3: Battery Life-Time and Range Use Case Example				
	Operating Mode	Specification	Typical Value	Unit
Use Case Operating Parameters	Warehouse Mode	Storage Time	1	years
		Average Current	3.8	µA
	Beaconing Mode	Beacon Interval In Active Mode	1000	msec
		Output Power In Active Mode	0	dBm
		Average Current In Active Mode	15	µA
		Average Current in Inactive Mode	2.5	µA
		Line-of-Sight(LOS) Range	30	m
Use Case Battery Life Based on Activity Level	Example 1: 10% Activity	Percentage of Life in Active Mode	10	%
		Percentage of Life in Inactive Mode	90	%
		Lifetime Average Current	5.0	µA
		Battery Lifetime (CR2032)	52	months
	Example 2: 50% Activity	Percentage of Life in Active Mode	50	%
		Percentage of Life in Inactive Mode	50	%
		Lifetime Average Current	10	µA
		Battery Lifetime (CR2032)	26	months
	Example 3: 90% Activity	Percentage of Life in Active Mode	90	%
		Percentage of Life in Inactive Mode	10	%
		Lifetime Average Current	15.1	µA
		Battery Lifetime (CR2032)	17	months

Note 1: Battery Lifetime is calculated based on the average current using a Renata CR2032 battery with 225mAh of battery life under typical conditions.
Note 2: Beacon interval is the Bluetooth advertising interval (advInterval) as defined in the Bluetooth Specification V5.0, Volume 6, Part B, Section 4.4.2.2.
Note 3: Range is measured outdoors, line-of-sight, with an iPhone™. 4S

6.4. REGULATORY

EMBP00 is certified and complies with the following regulatory requirements:

6.4.1. Regulatory Information CE

EM Microelectronic, as the responsible party for regulatory compliance, declares under our sole responsibility that as delivered the described product is in conformity with the RED Radio Equipment Directive 2014/53/EU, following the provisions of ERP Directive 2009/125/EC, EU RoHS Directive 2011/65/EU, including the amendment 2015/863/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment, and carries the CE-marking. Refer to emmicroelectronic.com for the signed declaration.

6.4.1.1. *SAFETY File*
1. Information on all plastics (flame rating and UL listing) model numbers
2. Battery: Specification, UL listing, and reports from vendor (Standards are UL 1642 and IEC/EN 62133)
3. PCB Board (same information as plastics)

6.4.2. *Regulatory Information USA*

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
- Part 15 – General emissions
- Part 15.247:2011 – Operation within the band 2.4-2.4835GHz

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

6.4.2.1. *Permitted Antenna*

This radio transmitter model, FCC ID: 2ACQR-EMBP0 has been approved by FCC to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Table 4: FCC Permitted Antenna	
Type	**Max Gain**
Integrated PCB IFA	1.5 dBi

6.4.3. *Regulatory Information Canada*

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Les changements ou modifications non expressément approuvés par la partie responsable de la conformité pourraient annuler l'autorisation de l'utilisateur d'utiliser l'équipement.

This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions: (1) This device may not cause interference; and (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

- ICES-003 – General emissions
- RSS-210:2010 – Low-power License exempt Radio Communication Devices

6.4.3.1. *Permitted Antenna*

This radio transmitter model, IC: 12155A-EMBP0 has been approved by the ISED to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Table 5: IC Permitted Antenna	
Type	**Max Gain**
Integrated PCB IFA	1.5 dBi

Le présent émetteur radio modèle, IC: 12155A-EMBP0 a été approuvé par ISDE pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Table 6: IC Permis Antenne	
Type	**Max Gain**
Integrated PCB IFA	1.5 dBi

6.4.3.2. *CAN ICES-3 (A/B)/NMB-3(A/B)*

This Class A/B digital apparatus complies with Canadian ICES-003

Cet appareil numérique de clase A/B est conforme à la norme Canadienne ICES-003

7. FIRMWARE

The following is a basic description of EMBP00 firmware functionality with SimpleBeacon based firmware.

7.1. STATE MACHINE OPERATION

Figure 3 shows the base operating conditions of the SimpleBeacon firmware. Configuration options are available and detailed in this section to enable, disable and modify a variety of the operating conditions of the core state machine. Operating modes of the state machine are indicated by blocks in the diagram and transition events are indicated with arrows.
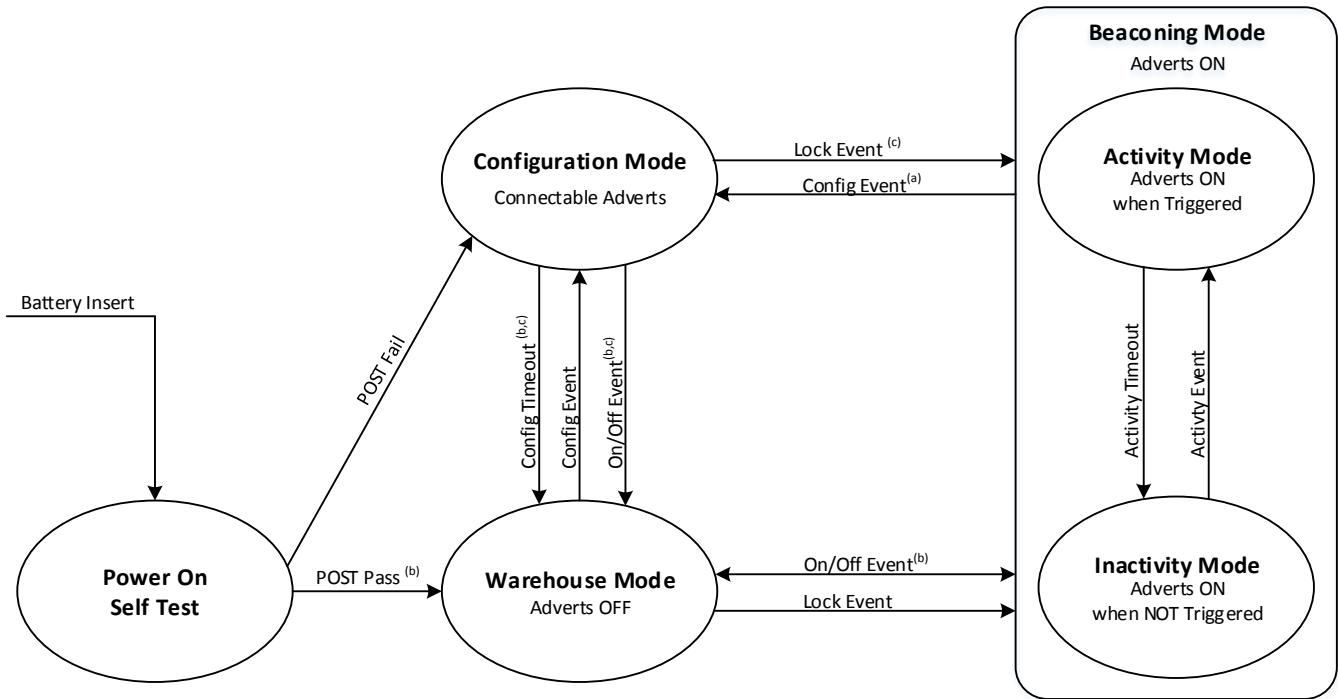
(a) Event disabled after Lock Event occurs
(b) Event can be configured transition to "Beaconing", rather than "Warehouse" Mode
(c) Disabled by POST failure

Figure 3: Firmware State-Diagram

The tables in this section lists options available for update using the SimpleBeacon Configuration Tools. Contact EM for technical details on creating custom configuration files outside of the SimpleBeacon Configuration Tools.

7.1.1. State Machine Configuration Options

Table 7: State Machine Configuration Options		
Parameter	**Options**	**Default Settings**
Hardware Features	Accelerometer	All Enabled
Startup Mode	Warehouse Mode Beaconing Mode	Beaconing Mode
Activity Event Source	Disabled Movement Tap Double Tap Freefall Flip	Disabled
On/Off Event Source	Disabled Flip	Disabled
Configuration Event Source	Disabled Flip	Flip
Configuration Timeout	0.1 to 6553.5 seconds	60 sec
Activity Timeout	0.1 to 6553.5 seconds	60 sec

7.1.2. Hardware Features

The accelerometer may be disabled in firmware. The option to disable this hardware feature is unavailable in the standard release of the SimpleBeacon Configuration Tools. Options to control these features can be made available on request.

7.1.3. Operating Modes

Operating Modes of the EMBP00 are indicated with ovals in Figure 3. The modes are fixed unless code patches are written and applied to redefine the states. Code patches may be developed using the EM SimpleBeacon SDK. Behaviors within specific states, such as advertisement profiles in the Beaconing Mode, can be redefined using the SimpleBeacon Configuration Tools. No source code development is required when using the SimpleBeacon Configuration Tools.

7.1.3.1. Power-On-Self-Test (POST)

On reset, a self-test feature is run to confirm functionality of the key electrical components for advertising. The self-test checks for hardware failures on the module. If the test passes, the device will enter the specified Startup Mode. If the test fails, the device will enter the Configuration Mode until the Reboot Delay timer has expired and resets the device. Table 8 shows the coverage of the tested hardware features.

Table 8: POST Tested Features
Accelerometer
48MHz High Frequency Crystal
32kHz Low Frequency Crystal
Invalid Configuration

If a POST failure is detected the device will disable the accelerometer and enter Configuration Mode until the Reboot Delay timer has expired and resets the device. From Configuration Mode the user can reconnect and load a valid configuration and read the error code.

7.1.3.2. Startup Mode

The startup mode is the mode that will be entered after POST or on a Configuration Timeout Event. The default definition of Startup Mode and reassignment options are as defined in Table 7.

7.1.3.3. Warehouse Mode

In Warehouse Mode, the EMBP00 is in its lowest consumption state to support long term storage. A Configuration Event, On/Off Event or Lock Event will all initiate exiting the Warehouse Mode. If a Configuration Event or On/Off Events are defined to use the flip option, the accelerometer will be sampling at the rate defined in the accelerometer configuration settings. The consumption will increase as defined in the accelerometer datasheet at the selected sampling rate. If the Configuration Event and On/Off Event are not defined to use the flip option, the accelerometer is in a power down state and the consumption of the device is as defined in Table 3. US the Battery Lifetime Calculator for more detailed estimations for setting combinations.

7.1.3.4. Configuration Mode

In Configuration Mode, the EMBP00 advertises a connectable advertisement at the default interval and output power as defined in Table 9. The advertisement rate and output power may be redefined by the

user. The configuration timer is started on entry into the Configuration Mode. If no connections are made before the Configuration Timeout occurs, the EMBP00 returns to the Startup State. Exit from Configuration Mode is initiated by Configuration Timeout. When a connection is made to the EMBP00, the part will stay in a connected state until the master terminates the connection or is out of range. On disconnect, the EMBP00 returns to the Startup State unless a reset was initiated during the connection.

The additional options to change the Packet Type is unavailable in the standard release of the SimpleBeacon Configuration Tools. Options to control these features can be made available on request.

| Table 9: Configuration Mode Advertisement Configuration Options		
Description	Options	Default
Packet Type	Connectable	Connectable
Advertisement Interval	30ms - 18hrs	500 ms
Tx Power Level Settings (dBm)	6.2 4.6 2.5 0.4 -1.4 -2.6 -4 -5.5 -6.9 -8.4 -9.9 -11.4 -13.1 -14.6 -16.4 -17.9 -29 -33.5	0.4 dBm

7.1.3.5. *Beaconing Mode*

In Beaconing Mode, the EMBP00 beaconing engine is enabled. The beaconing engine supports up to 10 advertisements running in parallel. Each advertisement may have a unique Packet Type, Advertisement Interval, and Transmit Power Level. In addition, each advertisement may be gated such that the advertisement is Always Enabled, Enabled Only When Active or Enabled Only When Inactive from Beaconing Mode. Table 10 shows the configuration options available for each advertisement.

Description of the transmit power level settings are from the EM9304 datasheet. Additional details regarding the impact on the operating behavior, consumption and performance of the device can be found in the datasheet. Modifications to the transmit output power and advertisement interval can have a dramatic impact on battery life. Consult the EM9304 datasheet and battery lifetime calculator to calculate the full impact of changes.

Table 10: Beaconing Mode Advertisement Configuration Options			
Description	Option	Default	
Packet Type	iBeacon™ Eddystone UID™ Eddystone URL™ Eddystone TLM™ altBeacon™ Connectable User Defined – Fixed Payload	Advertisement 1	Disabled
		Advertisement 2	Disabled
		Advertisement 3	Disabled
		Advertisement 4	Disabled
		Advertisement 5	Disabled
		Advertisement 6	Disabled
		Advertisement 7	Disabled
		Advertisement 8	Disabled
		Advertisement 9	Disabled
		Advertisement 10	Disabled
Advertisement Interval	30ms - 18hrs	Advertisement 1	Disabled
		Advertisement 2	Disabled
		Advertisement 3	Disabled
		Advertisement 4	Disabled
		Advertisement 5	Disabled
		Advertisement 6	Disabled
		Advertisement 7	Disabled
		Advertisement 8	Disabled
		Advertisement 9	Disabled
		Advertisement 10	Disabled

Transmit Power Level Settings (dBm)	+6.2 +4.6 +2.5 +0.4 -1.4 -2.6 -4.0 -5.5 -6.9	-8.4 -9.9 -11.4 -13.1 -14.6 -16.4 -17.9 -29.0 -33.5	Advertisement 1	+0.4
			Advertisement 2	+0.4
			Advertisement 3	+0.4
			Advertisement 4	+0.4
			Advertisement 5	+0.4
			Advertisement 6	+0.4
			Advertisement 7	+0.4
			Advertisement 8	+0.4
			Advertisement 9	+0.4
			Advertisement 10	+0.4
Advertisement Gating	Off Always Enabled Enabled when Active Enabled when Inactive		Advertisement 1	Disabled
			Advertisement 2	Disabled
			Advertisement 3	Disabled
			Advertisement 4	Disabled
			Advertisement 5	Disabled
			Advertisement 6	Disabled
			Advertisement 7	Disabled
			Advertisement 8	Disabled
			Advertisement 9	Disabled
			Advertisement 10	Disabled

The beacon engine combines the settings of the 10 defined advertisements to create an interleaved advertisement profile. Below is a diagram showing an example where three advertisements are enabled. Adv1 is an Eddystone™ URL packet type with an output power of 0dBm at a 1 second interval and a URL of www.Moving.com set to transmit when the module is moving. Adv2 is a Connectable advertisement with an output power of -14dBm at a 300ms interval and is always enabled. Adv3 is an Eddystone™ URL packet type with an output power of -5dBm at a 1.5 second interval and a URL of www.NotMoving.com set to transmit only when the module is not moving.
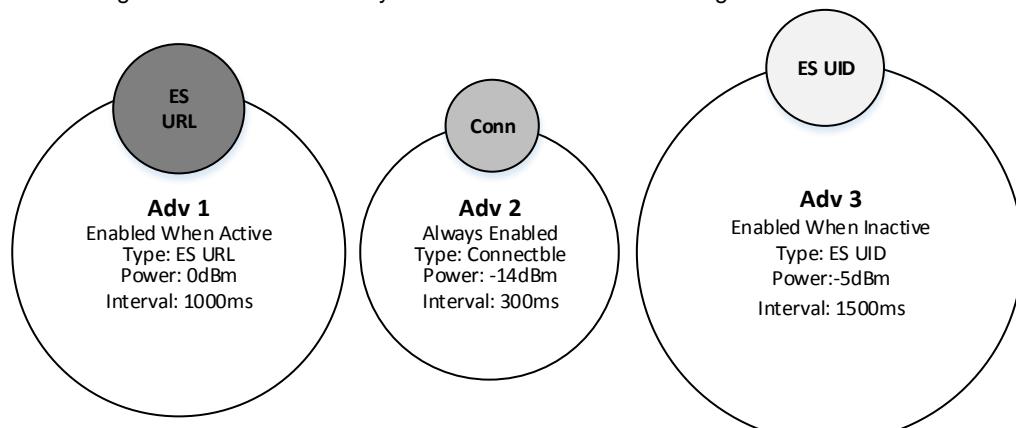

Figure 4: Example of three advertisements enabled

The beacon engine combines these three independent advertisement definitions to create appropriate interleaved advertisement profiles based on the Activity Events detected. The part is in an Inactivity Mode until an Activity Event is detected and the beacon engine manages interleaving the advertisement profiles is as shown in the figure below.
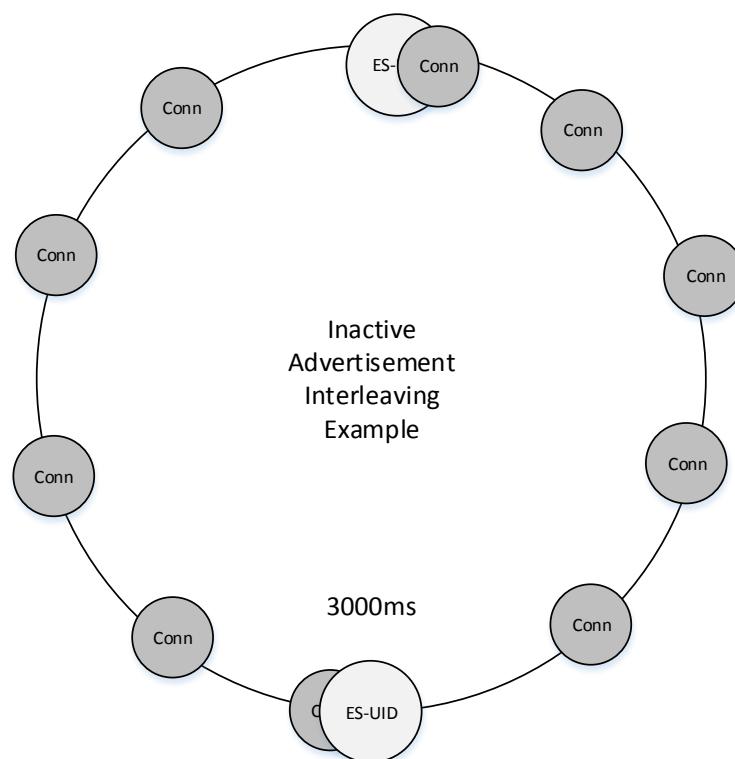
Figure 5: Example advertisement interleaving in Inactivity Mode

Once an Activity Event is detected, the beacon engine reengages to disable the On When Inactive advertisement and enables the On When Active advertisements. The resulting interleaved advertisement for profile in this example is shown below.
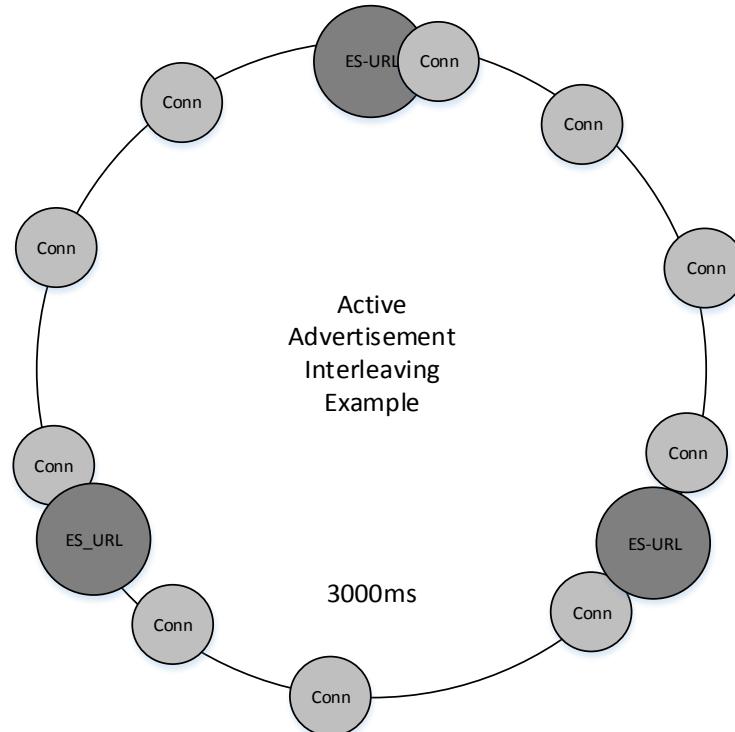
Figure 6: Example advertisement interleaving in Activity Mode

When multiple advertisements are running in parallel timing collisions may occur. The firmware will make priority decisions regarding which advertisement to send next. The advertising interval of one or more packets is extended by a minimum of 30ms when collisions occurs in order to prevent violation to BLE advertisement protocols.

7.1.3.5.1. Activity Mode

Activity Mode is a subset of Beaconing Mode. When advertisements are assigned to this Advertisement Gating option, the advertisement will only occur after an Activity Event, such as movement, has been detected and for the duration of time defined by the Activity Timeout. Advertisements assigned to the Always Enabled advertisement gating option will continue to be transmitted while in the Activity Mode.

7.1.3.5.2. Inactivity Mode

Inactivity Mode is a subset of Beaconing Mode. When advertisements are assigned to this advertisement gating option, the advertisement will only occur when not in the Activity Mode. Advertisements assigned to the Always Enabled advertisement gating option will continue to be transmitted while in the Inactivity Mode.

7.1.3.6. BLE Connection

A connection can be initiated from any mode where a connectable advertisement is sent. When a connection is made, all accelerometer interrupt sources are disabled. If the connection was made from Configuration or Activity Mode, the correlating timer continues to run while the connection is enabled. If the corresponding timer expires while the connection is enabled, the timeout event will occur on disconnect. If the corresponding timer does not expire while the connection is still enabled, the mode that the connection was initially made in will resume on disconnect. Specific services may initiate a Reset Event. Refer to Section 7.3 on the supported services for more details. A Reset Event will return the part to POST.

7.1.4. Mode Transitions

Mode transitions of the EMBP00 are indicated with arrows in the Figure 3. The start and ending mode of transitions are fixed unless code patches are written and applied. Code patches may be written using the EM Beacon SDK. The duration of a Configuration Timeout or an Activity Timeout can be redefined using the SimpleBeacon Configuration Tools. Additionally, the source of the Configuration Event and On/Off Event can be redefined using the SimpleBeacon Configuration Tools. No source code development is required when using the SimpleBeacon Configuration Tools.

7.1.4.1. Configuration Event

A Configuration Event generates a transition from the Beaconing Mode or Warehouse Mode into Configuration Mode. The Configuration Event may be assigned as defined in Table 9 using the SimpleBeacon Configuration Tools. No source code development is required when using the SimpleBeacon Configuration Tools.

If the Configuration Event is assigned to flip, the event will only be triggered when the module is rotated from the gravity vector pointing in the negative Z (1) direction to the gravity vector pointed in the positive Z direction.
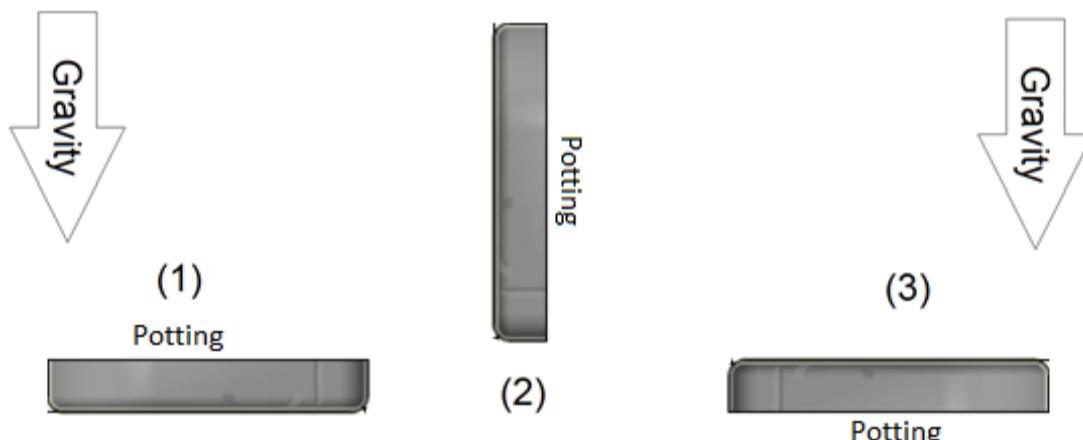
Figure 7: Configuration Event Flip Sequence

7.1.4.2. Configuration Timeout

On entry into the Configuration Mode, the configuration timer is started. A Configuration Timeout is generated when that timer expires and initiates a transition from Configuration Mode to the startup mode. The duration of the Configuration Timeout may be modified with the SimpleBeacon Configuration Tools as defined in Table 9. No source code development is required when using the SimpleBeacon Configuration Tools.

7.1.4.3. *On/Off Event*

An On/Off Event generates a transition from the Beaconing Mode to Warehouse Mode, from Configuration Mode to Beaconing Mode and from Warehouse Mode to Beaconing Mode. The On/Off Event may be modified as defined in Table 7 using the SimpleBeacon Configuration Tools. Refer to Figure 7 for the sequence required to detect the flip motion. No source code development is required when using the SimpleBeacon Configuration Tools.

7.1.4.4. *Activity Event*

An Activity Event generates a transition from the Inactivity Mode to Activity Mode. The Activity Event may be assigned as defined in Table 7. Refer to Figure 7 for the sequence required to detect the flip motion. No source code development is required when using the SimpleBeacon Configuration Tools.

7.1.4.5. *Activity Timeout*

An Activity Event generates a transition from the Inactivity Mode to Activity Mode. The Activity Event may be assigned as defined in Table 7.

On entry into the Activity Mode, the activity timer is started. An Activity Timeout is generated when the activity timer expires and initiates a transition from Activity Mode to the Inactivity mode. The duration of the Activity Timeout may be modified with the SimpleBeacon Configuration Tools as defined in Table 9. No source code development is required when using the SimpleBeacon Configuration Tools.

7.1.4.6. *Reset Event*

A Reset Event is initiated by battery insertion, toggling the enable signal from the test bus or from select BLE services. A Reset Event clears data RAM and returns to the POST state to reinitialize the part.

After a Reset Event a 500ms burst of connectable advertisements will be transmitted from the module.

7.1.5. *Accelerometer Configuration*

Configuration of key control registers on the accelerometer may be modified from the SimpleBeacon Configuration Tools. The configurable options are listed in Table 11. Full descriptions of the parameter are available in the STM LIS2DWL datasheet (see DocID029682 Rev4). Additional details regarding the impact on the operating behavior, consumption and performance of the device can be found in the accelerometer datasheet.

Table 11: Accelerometer Configuration Options				
Description	Available Options		Default	Units
Output Data Rate (ODR)	Low Power Settings Power Down 1.6 12.5 25 50 100 200	High Performance Settings Power Down 1.6 12.5 25 50 100 200 400 800 1600	12.5	Hz
Power Mode	Low Power High Performance		Low Power	-
Low Noise	Enable Disable		Disabled	-
Filter Bandwidth	Div 2 Div 4 Div 10 Div 20		Div 2	-
Full Scale Range (FSR)	2 4 8 16		2	G
Filter Selection	Low Pass High Pass		Low Pass	-
Movement Threshold	0 to 63		4	LSB
Movement Duration	0 1		0	Sequential Samples

	2		
	3		
Flip 4D/6D	4D Detection	6D	-
	6D Detection		
6D Threshold	50	80	Degrees
	60		
	70		
	80		
6D Low Pass Filter	Enable	Enabled	-
	Disable		
Tap Shock X Threshold	0 to 31	9	LSB
Tap Shock Y Threshold	0 to 31	9	LSB
Tap Shock Z Threshold	0 to 31	9	LSB
Tap Shock Time	4	16	Samples
	8		
	12		
	16		
Tap Quiet Time	2	2	Samples
	4		
	6		
	8		
Double Tap Latency	16	128	Samples
	32		
	48		
	64		
	80		
	96		
	112		
	128		
	144		
	160		
	176		
	192		
	208		
	224		
	240		
	256		
Tap Axii	X Axis	All Enabled	-
	Y Axis		
	Z Axis		
Freefall Duration	0-63	3	Samples
Freefall Threshold	5	10	LSB
	7		
	8		
	10		
	11		
	13		
	15		
	16		

Modifications to the accelerometer settings can have a dramatic impact on battery life. Consult the STM datasheet to calculate the full impact of changes to the accelerometer settings*.*

7.2. **ADVERTISEMENTS**

7.2.1. *Device Address*

Each EMBP00 has a unique factory-assigned address. The first 3 octets of the device address are the EM Microelectronic OUI assigned address from the IEEE 802 committee and subject to change without notice. The last 3 octets of the device address are uniquely assigned by EM Microelectronic. All advertisements enabled in the Beaconing and Configuration Modes share the same Device Address.

The device address to be used may be modified with the SimpleBeacon Configuration Tools. If the address 00:00:00:00:00:00 is entered, then the factory-assigned address will be used.

7.2.2. *Advertising Channels*

Advertisements are transmitted on channel 37, 38 and 39. Firmware options to disable up to two of the three advertisement channels for non-connectable advertisements are available. The option to disable the advertisement channels is unavailable in the standard release of the SimpleBeacon Configuration Tools. The

features can be made available on request in SimpleBeacon Configuration Tools. Disabling of advertisement channels is not compliant with Bluetooth specifications and compatibility with other BLE technology cannot be guaranteed when channels are disabled.

7.2.3. RSSI Table

The Eddystone™, iBeacon™ and altBeacon™ packet types include a one byte signed value that is used to communicate the signal strength of the packet being transmitted. This byte is retrieved from the RSSI Table in the EMBP00. The beacon engine will automatically retrieve the setting that correlates to the selected output power setting for the advertisement. Default values are assigned using the calibration procedure defined by Apple™ and an iPhone 4S™. The default settings are as defined in Table 12.

Table 12: RSSI Table	
Tx Power Level (dBm)	RSSI Table Entry (dBm at 1m)
6.2	-55
4.6	-57
2.5	-59
0.4	-61
-1.4	-63
-2.6	-64
-4	-66
-5.5	-67
-6.9	-68
-8.4	-70
-9.9	-71
-11.4	-73
-13.1	-75
-14.6	-76
-16.4	-78
-17.9	-79
-29	-91
-33.5	-95

The RSSI Table values may be modified using the SimpleBeacon Configuration Tools.

7.2.4. Connectable Advertisement

These Bluetooth advertising packets are connectable, undirected advertising events (ADV_IND) which follow the GAP specification according to the Bluetooth Specification V5.0, Volume 3, Part C, Section 11.

The friendly name used in the connectable advertisement may be redefined using the SimpleBeacon Configuration Tools. If the friendly name is left blank in the SimpleBeacon Configuration Tools, the name is automatically generated from the device address. Additionally the special character "$" in the friendly name will be replaced with the lowest nibble in hex of the device address.

The default friendly name is EM-$$$$$$.

7.2.5. Non Connectable Advertisements

These Bluetooth advertising packets are non-connectable, undirected advertising events (ADV_NONCONN_IND) which follow the GAP specification according to the Bluetooth Specification V5.0, Volume 3, Part C, Section 11.

7.2.5.1. iBeacon™ Format

The format of the iBeacon™ packet is described in the following specification: Proximity Beacon Specification Release R1 Draft D1, which can be obtained from Apple, Inc.

The UUID, Major ID and Minor ID used in the iBeacon™ advertisement may be redefined using the SimpleBeacon Configuration Tools. If the UUID is set to 0, the default UUID of 699EBC80-E1F3-11E3-9A0F-0CF3EE3BC012 is used. If the Major ID are set to 0, the Major ID from the second lowest two bytes of the device address. If the Minor ID are set to 0, the Minor ID from the lowest two bytes of the device address. For example, for a device with address: 0C:F3:EE:AA:BB:CC. If the Major ID is set to 0, the transmitted Major ID will be 0xEEAA. If the Minor ID is set to 0, the transmitted Minor ID will be 0xBBCC

7.2.5.2. *Eddystone™ UID and URL*

Refer to the Eddystone™ specifications available on GitHub for details on the payload of an Eddystone™ URL and Eddystone™ UID packet.

The URL, UID Namespace and UID Instance used in the Eddystone™ advertisement may be redefined using the SimpleBeacon Configuration Tools. If the URL parameter is left blank in the SimpleBeacon Configuration Tools, the default URL of <u>emdeveloper.com</u> is used. If the UID Namespace is set to 0 in the SimpleBeacon Configuration Tools, the default UID Namespace value is 699E-BC80-E1F3-11E3-9A0F. If the UID Instance is set to 0 in the SimpleBeacon Configuration Tools, the default UID Instance value is the device address.

7.2.5.3. *AltBeacon™ Formats*

Refer to the AltBeacon™ specifications available on GitHub for details on the payload of an AltBeacon packet.

The GUID, Major ID and Minor ID used in the altBeacon™ advertisement may be redefined using the SimpleBeacon Configuration Tools. If the GUID parameter is set to 0, the default GUID of 699EBC80-E1F3-11E3-9A0F-0CF3EE3BC012 is used. If the Major ID and Minor ID parameters are both set to 0 in the SimpleBeacon Configuration Tools, the Major ID and Minor ID are extracted from the lowest 4 bytes of the device address.

7.2.5.4. *User Defined Format*

A fixed payload of up to 31 bytes may be defined by the user. Compliance with BLE advertising specification and requirements are the responsibility of the user to maintain compatibility with third party BLE equipment.

7.3. **SUPPORTED BLE SERVICES**

7.3.1. *Firmware Over The Air (FOTA) Service*

Service UUID: 00007001-0000-0041-4c50-574953450000

The EM9304 Firmware Over-The-Air (FOTA) service allows the user to upload new configuration and code containers onto the EM9304. Containers may be uploaded into one of two memories: IRAM or OTP. In addition, the containers stored on the EM9304 may be listed and invalidated through the FOTA profile. The FOTA profile can also reset the part as well as turn off IRAM.

Details about the OTP, IRAM and patching are available in the EM9304 datasheet.

The Implementer's Guide for the EM9304 FOTA service is available through the development support forums.

The Invalidate command of the Memory Access Control Point Characteristic in the FOTA service is used to transition the part from Factory parameters to deployed parameters.

7.3.2. *Beacon Information Service*

Service UUID: F4000A80-DE94-078F-E311-35B1EE4FDB15

The Beacon Information Service is designed to allow users to read the current configuration status of the module.

The protocol is a command-response. To use the service, the remote app writes a command to the Command Characteristic and reads the response from the Data Characteristic. Refer to the EM Beacon SDK for more details on the protocol.

7.3.2.1. *Command Characteristic*

Characteristic UUID: F1000A80-DE94-078F-E311-35B1EE4FDB15

The Command Characteristic is a write-only characteristic. The complete list of commands is shown in Table 13.

Table 13: Beacon Information Service Commands		
Command	Description	Hex Code
Get Version	Request for the firmware version of the application.	0x01
Get Device Configuration	Request for the settings of the parameters in the Device Configuration tab of the SimpleBeacon Configuration Tools.	0x02
Get Advertising Configuration <n>	Request for the settings of the parameters in the Advert-x tab of the SimpleBeacon Configuration Tools. POST Advertisement: n=0 Configuration Mode Advertisement: n=1 Advertisement 1-10: n=16-25	0x03
Get Accelerometer Configuration	Request for the settings of the parameters in the Accelerometer Configuration tab of the SimpleBeacon Configuration Tools.	0x04
Get RSSI Table	Request for the settings of the parameters in the RSSI tab of the SimpleBeacon Configuration Tools.	0x05
Get Device Address	Request for the factory assigned Device Address	0x06
Get Diagnostic Code	Request usage and diagnostic information in event of failure.	0x07
Get Protocol ID	Request identifier structure	0x08
Generate On/Off Event	Issue and On/Off Event	0x0B
Get Factory Marker	Read the factory marker	0x0C
Get VBAT	Read battery voltage (100mV resolution)	0x0D
Get Diagnostics	Read Usage and diagnostic info	0x0E

The format of the command is

<Command>   <Optional Parameter>   <Bytes to Follow>   <Optional Data>

7.3.2.2. *Data Characteristic*

Characteristic UUID: F2000A80-DE94-078F-E311-35B1EE4FDB15

The Data Characteristic is a read-only characteristic. The format of the return is either the requested data or an error code. The first byte of the return is unique and indicates the type of response as defined in **Table 14**.

| Table 14: Beacon Information Data Characteristic		
First Data Byte	Description	Hex Code
Error Response	A detailed error code and additional data if any follows.	0x80
Configuration Patch	This response can be saved as a binary file and used as a 9304 patch file. The beacon produces responses in this format when the request is for the Device Configuration, Advertisement Configuration, Accelerometer Configuration, Factory Marker or RSSI Table.	0x33
Command Echo	Echo of the command code that generated the data	All Others

7.3.3. *Device Information Service*

SIG Service Assigned Number: 0x180A

The Device Information Service is the standard service defined by the Bluetooth SIG. This service exposes manufacturer information about a device. The Device Information Service is instantiated as a Primary Service. Only one instance of the Device Information Service is exposed on a device. The service defines 9 characteristics. Usage for the 9 characteristics are detailed in Table 15.

Table 15: Device Information Service			
Characteristic Name	Default	Configurable	Assigned Number
Manufacturer Name	EM Microelectronic	Yes	0x2A29
Model Number	blank	Yes	0x2A24
Serial Number	Factory MAC Address	No	0x2A25
Hardware Revision	Unused	No	0x2A27
Firmware Revision	5A.00.01.00.00	No	0x2A26
Software Revision	Unused	No	0x2A28
System ID	Unused	No	0x2A23
Regulatory Certification List	Unused	No	0x2A2A
PnP ID	Unused	No	0x2A50

8. TYPICAL FIELD ACTIVATION

As noted in Section 7, units are shipped in Factory Operating Conditions for activation in the field to convert to Deployment Operating Conditions.
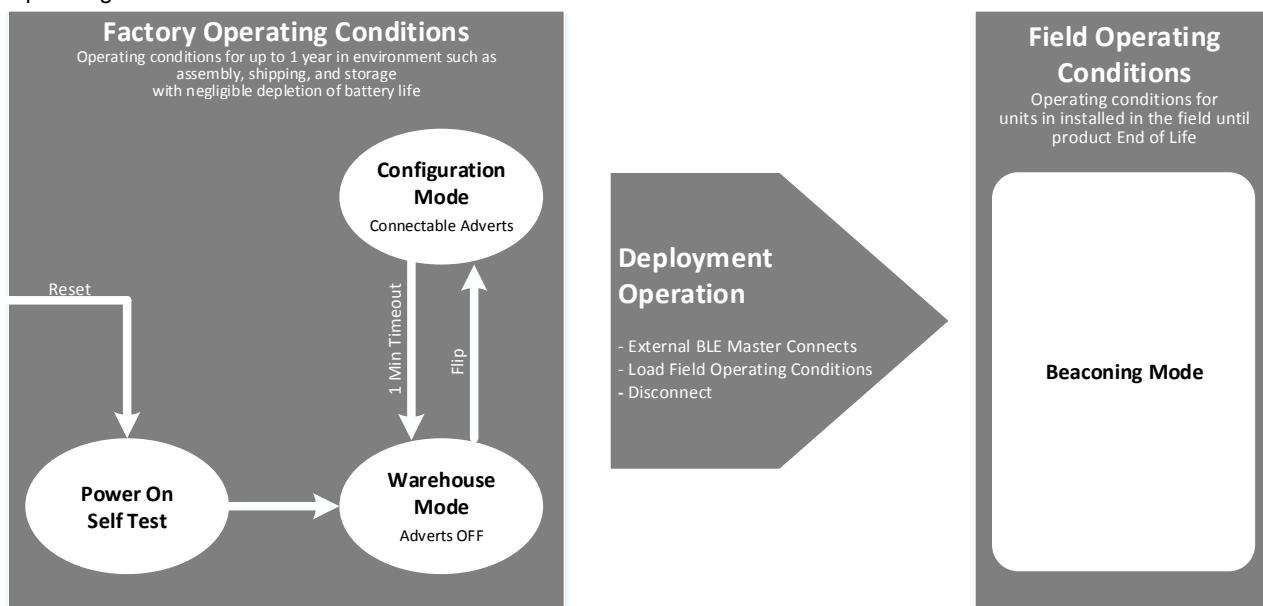
Figure 8: Configuration Event Flip Sequence

Refer to the EM Beacon Configuration Tools for mobile and PC support tools to support deployment and development of deployment tools.

9. UNIT LABEL

The label has the following contents:
- Model: EMBP00
- Unique Serial Number
- FCC-ID: 2ACQR-EMBP0
- IC: 12155A-EMBP0

- WEEE Marking
- CE Marking
- QR Code containing the unique serial number
- EM Microelectronic logo

Figure 9: Unit label

9.1. SERIAL NUMBER

The serial number is generated by reading the device address of EMBP00, reversing the byte order, and printing the number in decimal form.

For example:
Device Address: 0x0CF3EE001122 corresponds to Serial Number: 19864239403788

10. PACKING AND LABELING

10.1. FINISHED PRODUCT

10.1.1. Inner Packing

EMBP00 beacons are packed in custom antistatic trays.
- Only one tray per box can have parts from 2 different product lots.
- Tray size is 300 x 261 x 38 mm.
- Number of parts per tray is 100pcs.
- There are 4 trays per stack, excluding cover tray.

A label is applied on each stack. The minimum information on the label is specified in Figure 10.

EM P/N:
Mfg date:
Module Lot Nr:
Qty:

Figure 10: Packing label information

10.1.2. External Packing

Tray stacks are packed in cardboard box.
- Quantity of parts per box is 800 pcs (2 tray stacks).
- Box dimensions are 37 x 55 x 43 cm.

A label is applied on each box. The minimum information on the label is specified in Figure 11.

EM P/N:
Mfg date:

Module Lot Nr:
Qty:
Weight:

Figure 11: Panel packing label information

11. ENVIRONMENTAL SAFETY

11.1. RESTRICTION OF HAZARDOUS SUBSTANCES (ROHS)

EM Product is compliant with the EU RoHS Directive 2011/65/EU and its amendments, including the amendment 2015/863/EU, on the restriction of the use of certain hazardous substances in electrical and electronic equipment, and does not contain any of the substances listed below above the concentration levels specified in the Directive 2015/863/EU:

Lead (Pb): <1000 ppm
Mercury (Hg): <1000 ppm
Cadmium (Cd): <100 ppm
Hexavalent Chromium (Cr VI) <1000 ppm
Polybrominated Biphenyls (PBB): <1000 ppm
Polybrominated Diphenyl Ethers (PBDE): <1000 ppm
Bis(2-ethylhexyl) Phthalate (DEHP) : <1000 ppm
Butyl benzyl Phthalate (BBP): <1000 ppm
Dibutyl Phthalate (DBP): <1000 ppm
Diisobutyl Phthalate (DIBP): <1000 ppm

11.2. "HALOGEN FREE" - IEC 61249-2-21:2003.

EM Product is compliant with the "Halogen Free" - IEC 61249-2-21:2003 Standard and does not contain brominated and chlorinated compounds above the threshold level for each homogeneous material within the Product.

Chlorine (Cl): <900 ppm
Bromine (Br): <900 ppm
Total halogens (limited to Br + Cl): <1500 ppm

11.3. REACH AND SVHC LIST

EM Product is compliant with the EU Regulation 1907/2006 (REACH) and the SVHC list (Substances of Very High Concern). The SVHC must be below the limit of 0.1% set by REACH Article 33, as specified in the Candidate list published by ECHA (European Chemical Agency)
https://www.echa.europa.eu/web/guest/candidate-list-table
EM Product is compliant with the restrictions imposed by the 76/769/EEC European Directive and which have been included in the Annex XVII of REACH.

11.4. PRODUCT HARDWARE RECYCLING (WEEE)

The Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE) aims to reduce the waste arising from electrical and electronic equipment, and improve the environmental performance of everything involved in the life cycle of electrical and electronic equipment.

Instructions for Disposal of Waste Equipment by Users in Private Households
This symbol on the product or on its packaging indicates that this product must not be disposed of with your other household waste. Inappropriate disposal may be harmful. Instead, it is your responsibility to dispose of your waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, please contact your local city office, your household waste disposal service or the sales point where you purchased the product.

Responsibilities
EM is committed to meeting the requirements of the European Union's WEEE Directives.
However, the System Integrator of EM Product has the responsibility for the collection and recycling of the Beacon after its end of life.

EM Customer can send back the collected EM Product to EM at DAP conditions (Delivery at Place). If the Lithium batteries are included in the air freight shipment, IATA DGR (Dangerous Goods) rules are to be applied.

<u>Specifics on battery</u>
The Directive 2012/19/EU does apply to batteries and requires their removal from the electronic equipment and their separate collection. Once removed from equipment, used batteries are governed by the Batteries Directive 2006/66/EC.

12. ORDERING INFORMATION

The EMBP00 is available as a finished product with full FCC, IC, and CE certification. The EMBP00 ordering information is shown in Figure 12 and the order numbers are shown in Table 16.

EMBP00   -   F171   -   H2100

Base Part Number
EMBP00: Standard Version

Housing Version:
Hwxyz: housing, color, label, battery
  w – housing color
  x – marking layout
  y – open
  z – open
H3100: Blue Cup; EM Marking

Firmware Version:
F171: Standard Product FW V1.1
Other: Assigned by EM
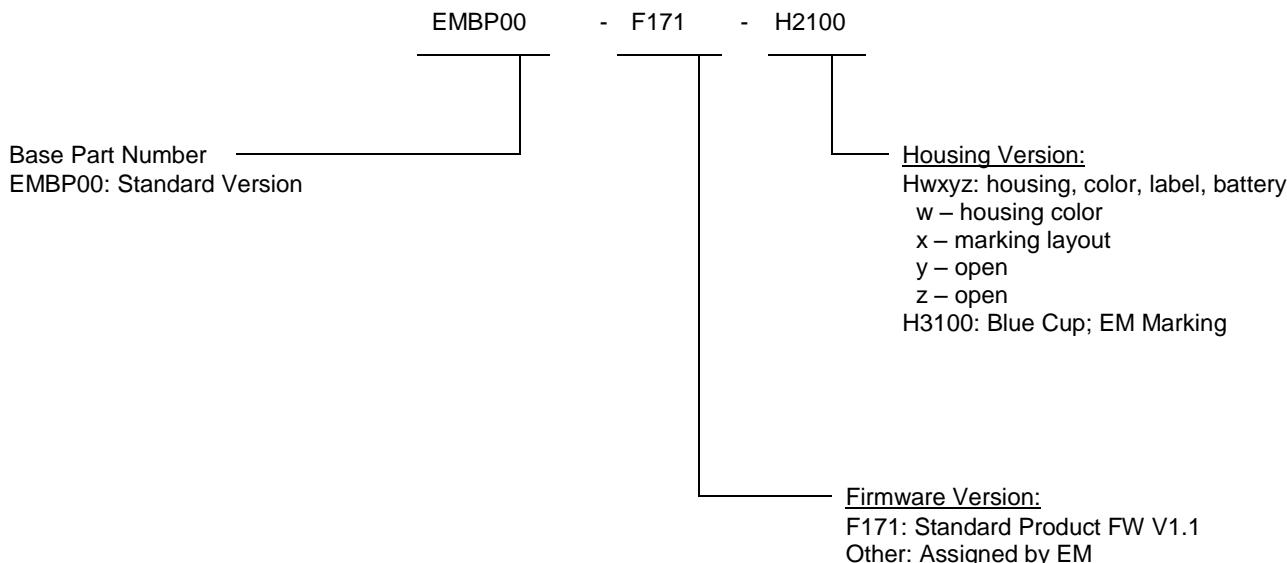
Figure 12: EMBP00 Ordering Information

Table 16: EMBP00 Related Order Nu mbers

ORDER NUMBER	DESCRIPTION	CONTAINER	UNITS PER CONTAINER	MINIMUM ORDER QUANTITY
EMBP00-F171-H3100	Standard Accelerometer Beacon	Box	800	800

13. CONTACT INFORMATION

Inquiries for lead-times, quotes, orders:
EMDirect@emmicroelectronic.com

14. REFERENCE DOCUMENTS

EM9304 Device Specification
LIS2DWL Device Specification
Bluetooth Specification V5.0

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