



ENTERPRISE GRADE PROXIMITY BEACON WITH LONG AUTONOMY



DESCRIPTION

EMBE01 is an enterprise grade Bluetooth™ v4.1 compatible proximity beacon. It is particularly suitable for mass deployment by system integrators in demanding environments thanks to long battery life and robust housing. It is part of the EM Microelectronic line of Bluetooth v4.1 beacon family. EMBE01 advertises ID data that is compatible with a variety of common beacon standards and connectable and non-connectable variants.

The unit comes in an IP65 rated weatherproof enclosure, using 4 standard AA batteries for power (batteries not delivered with unit). A push-button and a magnetic reed switch provide respectively internal and external control, along with two LEDs for feedback to the user.

EMBE01 is shipped pre-programmed supporting 6 common advertisement standards:

- | ID Data: Configurable UUID, Major ID, Minor ID, and Output power. iBeacon compatible technology
- | Alt Beacon : Configurable advertisement type, beacon ID, manufacture's ID
- | Eddystone™ URL configurable URL
- | Eddystone™ UID configurable Namespace ID and Instance ID
- | Eddystone™ TLM
- | EM Sensor Beacon

EMBE01 can be delivered in any quantity with guaranteed unique ID numbers. A unique serial number is printed on the label and encoded in a QR code for optical scanning.

EMBE01 firmware can be customized for individual deployments with the Enterprise Beacon Development Kit. Complete source code and libraries are available through emdeveloper.com for registered customers.

EMBE01 is FCC, IC, and CE certified, RoHS and REACH compliant.

FEATURES

- | **Rugged Weatherproof Enclosure**
 - o IP-65 rating, -40C to +60C operating range
 - o Size: 100x80x28mm; Weight: 160g (w/o batteries)
 - o Long autonomy and four replaceable AA batteries (not included)
 - o Integrated push-button, magnetic reed switch
 - o Red and green LED indicators visible through the casing
 - o Wall Mount accessory
- | **Bluetooth v4.1 Support, including:**
 - o Non-connectable advertisement
 - o Connectable advertisement
 - o Connection from an initiating central
 - o GATT service support
- | **Unique Identification**
 - o UUID:
699EBC80-E1F3-11E3-9A0F-0CF3EE3BC012
 - o Unique Major and Minor IDs (serialized)
 - o Unique Serial Number
 - o Serial number, Major/Minor ID embedded in QR Code for deployment
- | **Firmware and Parameter Upgrades Over The Air**
 - o Custom GATT services & supporting app to update standard advertisement parameters of advertisements (enable, disable and configure all advertisement parameters)
 - o Custom GATT service supporting full update of the application firmware and Bluetooth stack

APPLICATIONS

- | Indoor Navigation
- | Item Tracking
- | Authorized Access
- | Digital enhancement of visual displays
- | Location Based Notification



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1. PRODUCT DESCRIPTION

The EMBE01 is a Bluetooth v4.1, 2.4 GHz RF electronic beacon with proximity capability, compatible with most common beacon standards with a low cost design for mass production.

The EMBE01 expands EM's smart beacon portfolio (EMBC01, EMBC02) by bringing in enterprise-grade performance. It is designed for using 4 AA batteries for high autonomy and comes with an IP65 housing for increased robustness in demanding environments.

Configurable Advertisement Features:

Various advertisements can be considered, with the configuration options defined below can be added to the device via a custom GATT service:

- | **Fixed content packet types** – Including, but not limited to ID Data, Eddystone UID and URL
- | **Sensor based packet types** – Including, but not limited to EM Sensor Packets and Eddystone TLM packets
- | **Signal output strength steps** - Ranging from -18dBm to +4dBm with 8 configurable levels
- | **Transmission Interval** – Uniquely defined at 10ms accuracy to each packet defined
- | **Connectable/Non-connectable Advertisements**
- | **Advertisement MAC Address**

Long Battery Life:

- | 4 Replaceable AA batteries (not included)
- | High autonomy
 - 1.5 year battery life at 0dBm output power and 100ms advertisement interval for non-connectable advertisement
 - 4 year battery life at 0dBm output power and 500ms advertisement interval for connectable advertisement

Normal Operating Conditions:

- | -40 to +60 C
- | Weather proof (IP-65 rating)

Robust and Lightweight:

- | Rugged Polycarbonate/Polyester alloy housing
- | Dimensions: 100x80x28mm
- | Weight: 160g (w/o batteries)

Certifications:

- | Environmental: RoHS, REACH
- | RF: FCC, IC, CE
- | Mechanical:
 - IP65 waterproof rating according to IEC 60529.
 - UL 94 V-0 flammability rated plastics

Compatible With:

- | Bluetooth v4.1 Ready Devices
- | Most Common Beacon Standards and proprietary formats

Included Hardware:

- | A white, industrial grade polycarbonate/Polyester alloy plastic enclosure
- | Internal push button for mode changes
- | Externally visible green and red LED for user feedback
- | A permanent label with a unique serial number and QR Code
- | Magnetic reed relay to allow user control without opening the case

Fully Customizable:

- | Development kit available
- | Adjustable parameters
 - Packet type and contents, UIDs, beacon interval, power level all configurable
 - Parameters may be adjusted in firmware or through the provided custom GATT service
- | Modifiable firmware available through EMDeveloper.com
- | Custom GATT service provided for updating advertisement parameters
- | Fully updatable firmware over the air (FOTA)

2. ENVIRONMENTAL AND STORAGE CONDITIONS

The operating and storage conditions are listed in Table 1 Environmental and Storage Conditions.

PARAMETER	UNIT/CONDITION
Module operating temperature and humidity range	-40°C to 60°C and 0 to 90% RH
Weatherproof	Module can be used in outdoor conditions. It is rated IP65 according to IEC 60529.
Module storage temperature and humidity range	Modules must be stored in original EM packing at Temp=25°C±10°C / RH≤70%.

Table 1 Environmental and Storage Conditions

3. PRODUCT OUTLINE DIMENSIONS

The EMBE01 finished product outline dimensions are shown in Figure 3-1 EMBE01 finished product outline dimensions. Units are in mm.

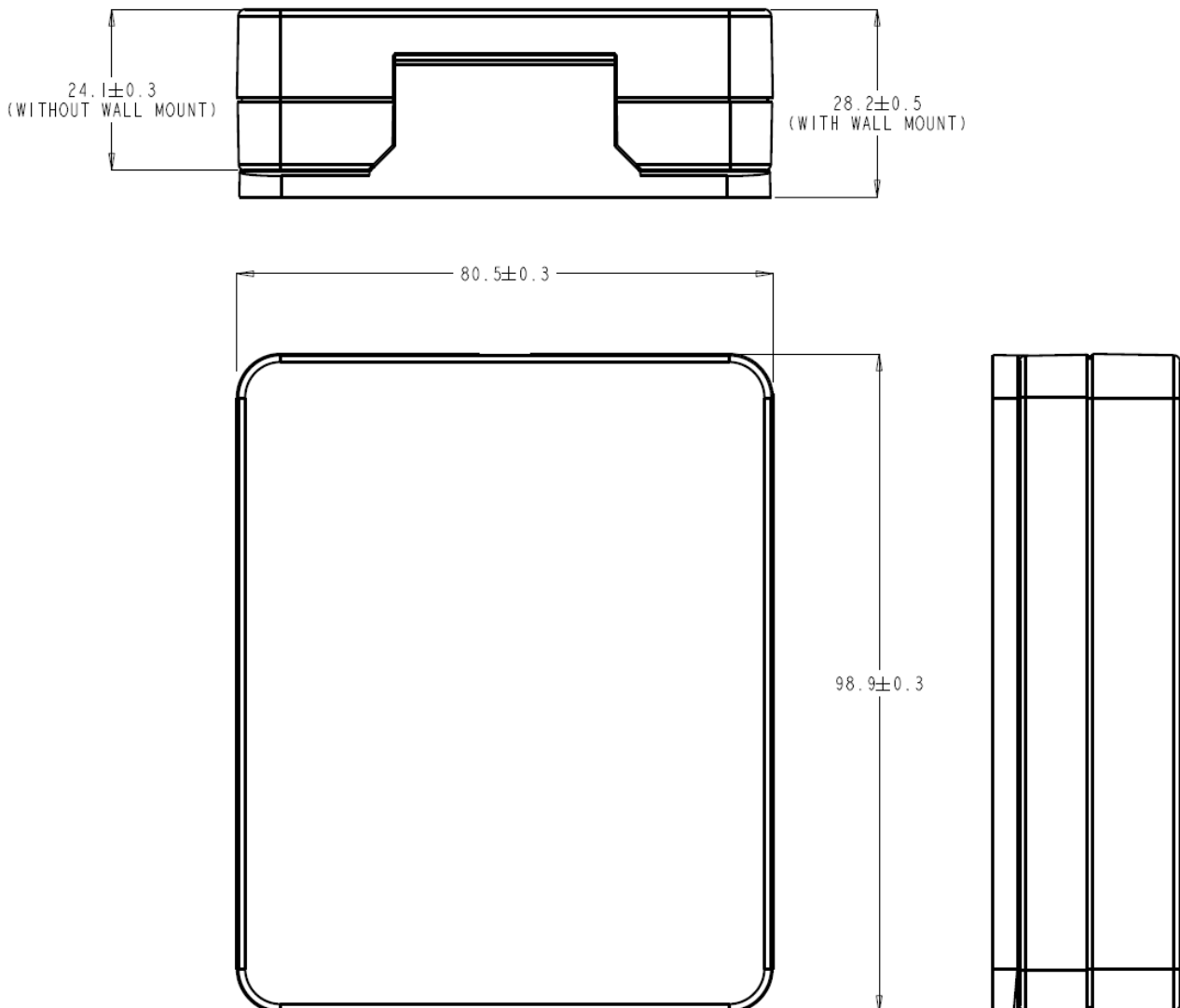


Figure 3-1 EMBE01 finished product outline dimensions

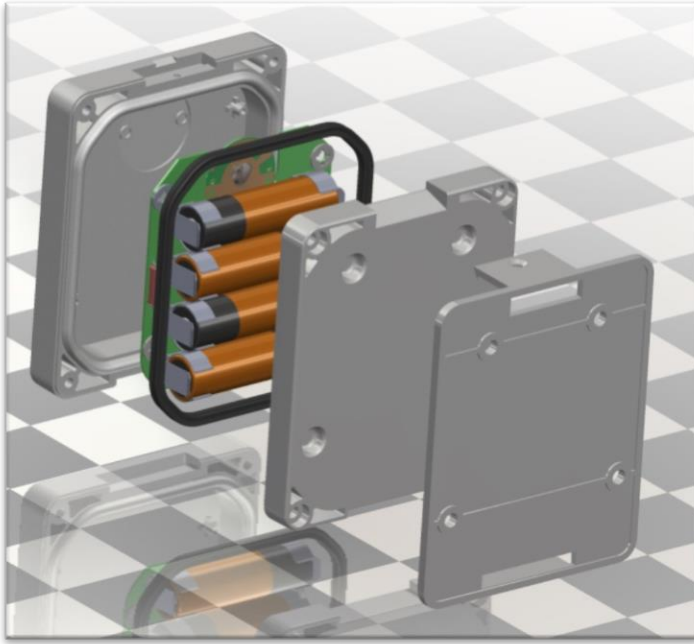


Figure 3-2 Exploded view of product

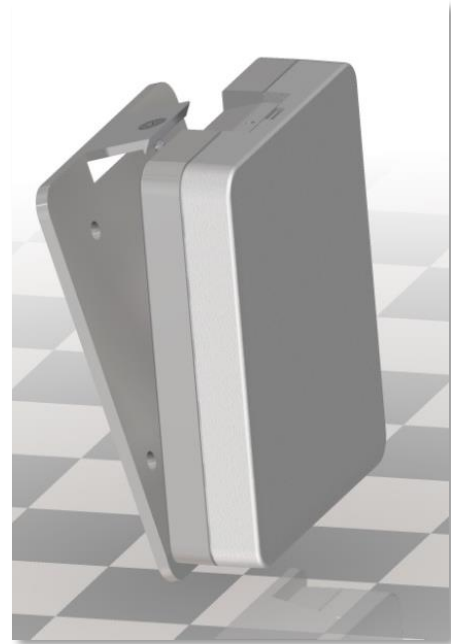


Figure 3-3 Exterior drawing of product

4. MECHANICAL

4.1. BATTERIES

The module is powered with 4 standard AA batteries. Batteries are not provided with the module.

Industrial grade batteries are recommended for installations. EM Microelectronic recommends Duracell Coppertop Alkaline batteries. Low grade batteries have an increased out-gassing at end of life that may result in oxidation and degrade performance of the electronics.

The following precautions should be observed to guarantee maximum performance.

- Take care to fit batteries correctly, observing the 'plus' and 'minus' signs of the battery and module
- Replace all four batteries simultaneously by fresh batteries of the same brand and type
- Remove dead batteries from the module
- Remove batteries from units that will not be used for extended periods of time

In case of a shock to the module, for example if dropped to the floor, it is possible that an intermittent power cut occurs, thus resetting the module firmware (See section 6.1). If this happens, please follow these steps:

1. Open the module and verify that all four batteries are properly held in the battery holders
2. Press the push button to reach the desired mode of operation
3. Close and reinstall the module

4.2. PUSH BUTTON

A tactile push button switch is accessible only from the inside of the case for enhanced security modes.

In the EMBE01 standard firmware, the switch is used to change modes.

Functions of the button can be modified via firmware modifications.

4.3. REED SWITCH

The reed switch is activated when a magnet is placed near the indicated area of the case in Figure 4-1 Location of reed switch.

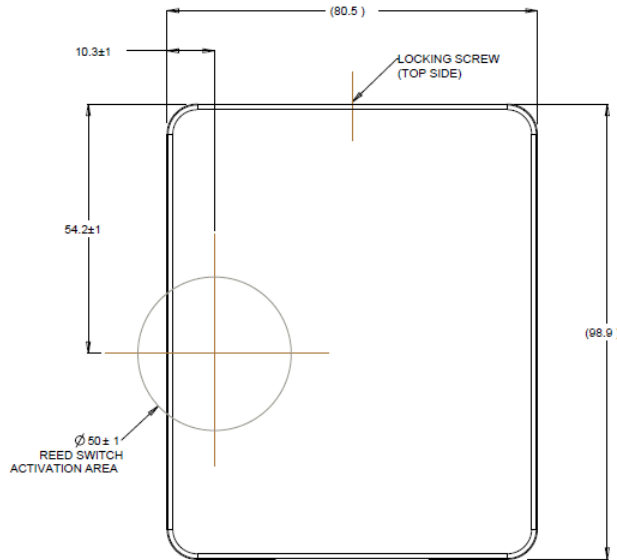


Figure 4-1 Location of reed switch

In the EMBE01 standard firmware, activation of the reed switch is used to enable the connectable advertisement for over-the-air updates to the advertisement settings or complete firmware.

Functions of the reed switch can be modified via firmware modifications using the distributed firmware.

4.4. LED

The green and red LEDs are visible through the plastic enclosure under indoor lighting conditions. LEDs are used to indicate the operating mode of the beacon.

Functions of the LED can be modified via firmware modifications.

4.5. SCREWS

The Front and Back housings are fastened with 4 thread forming screws for plastics, 3.63-1.34, 16mm length, Phillips head screws.

The 4 screws are delivered in a PE bag enclosed in the snap fitted housings.

Care should be taken when installing screws to make tight hold between front and back housings to retain the full IP rating. Installation of the device without using the screws will void the IP rating

4.6. WALL MOUNT

The module is delivered with a Wall Mount accessory snap-fitted with the 2 housings. Outline dimensions and screw locations are shown in Figure 4-2 Wall Mount screw locations.

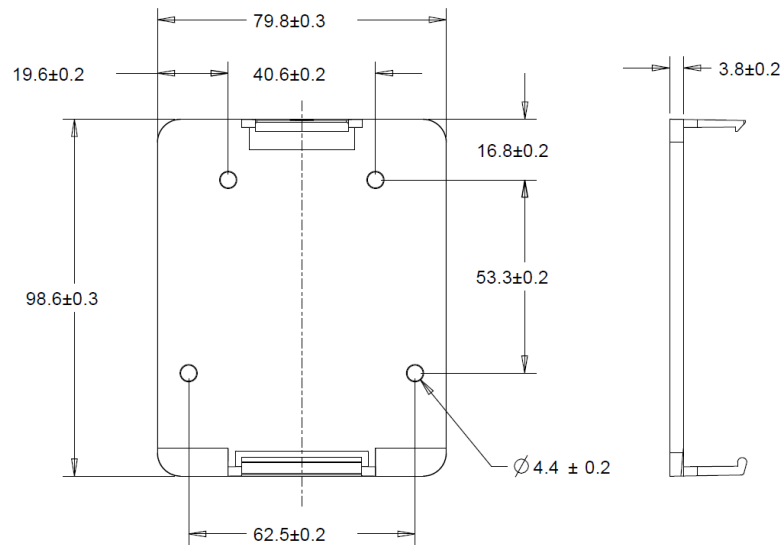


Figure 4-2 Wall Mount screw locations

4.7. LOCKING SCREW

The module can be securely fastened to the Wall Mount accessory with a locking screw (thread forming screws for plastics, 3.63-1.34, 15.9mm length), Philips drive #1.

This screw is included in the PE bag of screws for sealing the device.



5. ELECTRICAL

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

5.1. HANDLING PROCEDURES AND ABSOLUTE MAXIMUM RATINGS

This device has built-in protection against high static voltages or electric fields; however, anti-static precautions must be taken as with any CMOS components. Unless otherwise specified, proper operation can only occur when all terminal voltages are kept within the specified voltage range. The absolute maximum ratings of EMBE01 are listed in Table 2 Absolute Maximum Ratings.

PARAMETER	MIN	MAX	UNIT
Supply Voltage VCC - VSS	-0.3	3.8	V

Table 2 Absolute Maximum Ratings

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

5.2. GENERAL OPERATING CONDITIONS

The general operating conditions of EMBE01 are listed in Table 3 General Operating Conditions.

PARAMETER	MIN	TYP	MAX	UNIT
Supply Voltage (VCC)	2.0	3.0	3.6	V
Temperature range	-40	25	+60	°C

Table 3 General Operating Conditions

5.3. ELECTRICAL CHARACTERISTICS

The electrical characteristics of EMBE01 are given in Table 4 Advertisement Energy per Advertisement. Data from this table can be used to extrapolate battery lifetime calculations in a user defined installation. Data from Table 5 Battery Life Estimations² is extrapolated from the measured data of Table 4 Advertisement Energy per Advertisement using the equation provided. Unless otherwise specified: VCC=3.0V, T=25°C

Operating Mode	Specification	Typ	Unit
Sleep Mode	Average Current	2.5	µA
	Transmission Time	7	ms
Non-Connectable Advertisement	Energy Per Advert. (+4dBm)	11.2	nAh
	Avg Curr During Advert. (+4dBm)	5.7	mA
	Energy Per Advert. (0dBm)	10.0	nAh
	Avg Curr During Advert. (0dBm)	5.1	mA
	Energy Per Advert. (-18dBm)	8.6	nAh
	Avg Curr During Advert. (-18dBm)	4.4	mA
	Transmission Time	15.6	ms
Connectable Advertisement	Energy Per Advert. (+4dBm)	17.5	nAh
	Avg Curr During Advert. (+4dBm)	4.0	mA
	Energy Per Advert. (0dBm)	16.6	nAh
	Avg Curr During Advert. (0dBm)	3.8	mA
	Energy Per Advert. (-18dBm)	15.6	nAh
	Avg Curr During Advert. (-18dBm)	3.6	mA

Table 4 Advertisement Energy per Advertisement



Common figures for battery lifetime are provided in Table 5 Battery Life Estimations². Data is calculated from the measured data of Table 4 Advertisement Energy per Advertisement.

$$BatteryLifetime(hr) = \frac{BatteryCapacity(mAh)}{\sum SlotAverageCurrent}$$

$$SlotAverageCurrent = SleepCurrent(mA) * \frac{Interval - TransmissionTime}{Interval} + AvgAdvertCurrent(mA) * \frac{TransmissionTime}{Interval}$$

For example,

An Eddystone UID (NonConn) event was enabled at a 250ms interval and 0dBm

An IDData event (NonConn) was enable at 50ms and -18dBm

An EMEntOTA (Conn) event was enabled with a 375ms interval and +4dBm

$$ESUID \quad AvgCurr = 2.5\mu A * \frac{250ms - 7ms}{250ms} + 5.1mA * \frac{7ms}{250ms} = 0.14mA$$

$$IDDate \quad AvgCurr = 2.5\mu A * \frac{50ms - 7ms}{50ms} + 4.3mA * \frac{7ms}{50ms} = 0.60mA$$

$$EMEntOTA \quad AvgCurr = 2.5\mu A * \frac{375ms - 15.6ms}{375ms} + 4mA * \frac{15.6ms}{375ms} = 0.16mA$$

$$AvgCurrent = EMEntOTA \quad AvgCurr + ESUID \quad AvgCurr + IDDate \quad AvgCurr = 0.9mA$$

$$BatteryLife(hr) = \frac{4400mAh}{0.9mA} = 4888hrs = 7 \text{ months}$$

Operating Mode	Specification	Typ	Unit
Non-Connectable Advertisement	+4dBm @ 100ms	15	month
	+4dBm @ 500ms	74 ³	month
	0dBm @ 100ms	17	month
	0dBm @ 500ms	82 ³	month
	-18dBm @ 100ms	20	month
	-18dBm @ 500ms	95 ³	month
Connectable Advertisement	+4dBm @ 100ms	9.8	month
	+4dBm @ 500ms	48 ³	month
	0dBm @ 100ms	10.3	month
	0dBm @ 500ms	50 ³	month
	-18dBm @ 100ms	10.8	month
	-18dBm @ 500ms	53 ³	month

Table 5 Battery Life Estimations²

Range of the beacon is measured in an anechoic chamber in continuous modulation mode with a calibrated reference antenna. Measurements are taken across the three advertisement channels and min, max and average range is calculated from these



measurements and reflected in Table 6 Open Air Range⁴ assuming a receiver with sensitivity of -90dBm. Range in specific installations will vary based on the environment and receiver used.

Operating Mode	Specification	Typ	Unit
Output Power 4dBm	Measured output power at 1m	-61	dBm
	Calculated range for -95dBm at receiver	90	m
Output Power 2dBm	Measured output power at 1m	-63	dBm
	Calculated range for -95dBm at receiver	60	m
Output Power 0dBm	Measured output power at 1m	-65	dBm
	Calculated range for -95dBm at receiver	50	m
Output Power -3dBm	Measured output power at 1m	-68	dBm
	Calculated range for -95dBm at receiver	30	m
Output Power -9dBm	Measured output power at 1m	-72	dBm
	Calculated range for -95dBm at receiver	15	m
Output Power -12dBm	Measured output power at 1m	-74	dBm
	Calculated range for -95dBm at receiver	12	m
Output Power -15dBm	Measured output power at 1m	-79	dBm
	Calculated range for -95dBm at receiver	6	m
Output Power -18dBm	Measured output power at 1m	-82	dBm
	Calculated range for -95dBm at receiver	4	M

Table 6 Open Air Range⁴

Note 1: Beacon interval is the Bluetooth advertising interval (advInterval) as defined in the Bluetooth Specification V4.0, Volume 6, Part B, Section 4.4.2.2.

Note 2: Battery Lifetime is calculated data based from measured data generated using equations provided

Note 3: Typical manufactures limit for AA batteries are 7 year shelf life or 84 months and may reduce battery lifetime from calculated values.

Note 4: Actual range can be impacted by alternate receiver sensitivities and non-open air environments.

5.4. SAFETY FUSE

To prevent excessive heating of the module in case of an electrical defect, a safety fuse is inserted between the batteries and the active circuits. In case of a non-functional module, first replace the batteries and check the LED status after pressing the push button. If the module still does not operate, please return the failing unit, using the EM customer return policy described on the EM Microelectronic site: www.emmicroelectronic.com/policies.

5.5. REGULATORY

EMBE01 complies with the following regulatory requirements:

5.5.1. USA-FCC

- | Listed as 2ACQR-EMBE01
- |
- | Part 15 – General emissions
- | Part 15.247:2011 – Operation within the band 2.4-2.4835GHz
- | Parts 15.205 and 15.209 – Spurious emissions

5.5.2. CANADA-IC

- | Listed as 12155A-EMBE01
- |
- | ICES-003 – General emissions
- | RSS-210:2010 – Low-power License exempt Radio Communication Devices

5.5.3. CE

- | Radio Equipment Directive RED 2014/53/EU
- |
- | The Declaration of Conformity can be obtained from EM Microelectronic

6. FIRMWARE

EMBE01 standard firmware shipped on the EMBE device advertises non-connectable ID Data and connectable EMEntOTA packet types to enter Firmware Over the Air mode. A long press of the button or engagement from the reed switch will engage connectable packet types. From this mode, additional advertisements can be added to the device using the Enterprise Android app.

Modifications to the application space in the firmware can be done using the EMBE01 SDK available on www.emdeveloper.com.

6.1. EMBE01 STANDARD APPLICATION SPACE STATE MACHINE

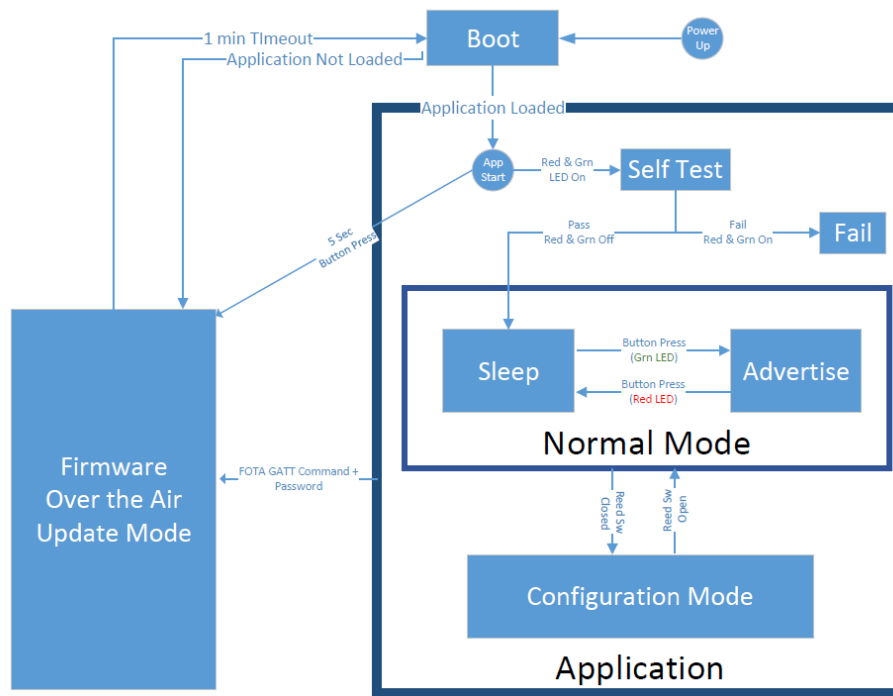


Figure 6-1 EMBE01 State-Diagram

6.1.1. SELF-TEST STATE

The self-test function tests the following functions:

- | Perform and verify a system reset
- | Verify battery voltage measurement
- | Verify proper version and operation of the EM9301
- | Perform calibration of the EM9301 and verify calibration results

If the test passes, both LEDs will flash. If the test fails, both LEDs will turn on and remain on.

It is recommended to keep this section of code for all custom firmware development. This section of code also includes functions that are critical to production testing for high volume cases where custom firmware is ordered from the factory.

6.1.2. GENERAL APPLICATION SPACE

The application space defines button and reed switch behaviours, state changes, advertisement modes and sensor configurations. The application space comes from the factory with the above configuration and parameters, but can be modified using the SDK that can be downloaded from www.emdeveloper.com. There is approximately 72k of flash available for custom applications and behaviours in addition to the EMBE01 base firmware.

Normal and configuration modes are specific to the EMBE01 standard firmware and can be re-defined by a custom application.

6.1.2.1. NORMAL MODE

In the Normal Mode (Reed switch not closed), the beacon will advertise any active advertisement event or sensor event at the defined settings. Several advertisements can be enabled during this mode and will operate on their own set of parameters.



6.1.2.2. CONFIGURATION MODE

In Configuration Mode, all advertisements are disabled except for a single event that is reserved for the custom EMEntOTA connectable advertisement. This operating mode is intended to allow site operators to make the beacon connectable and configurable without opening the case, but also without requiring connectable advertisements to be sent when an operator is not present, as an added security measure.

6.1.3. ADVERTISEMENT ARCHITECTURE

The EMBE01 is capable of handling a variety of advertisements, each having a unique set of parameters, and the following properties may be configured:

- | **Fixed content packet types** – Including, but not limited to ID Data, Eddystone URL and Eddystone UID
- | **Sensor based packet types** – Including, but not limited to EM Sensor Packets and Eddystone TLM
- | **Signal output strength steps** - Ranging from -18dBm to +4dBm with 8 configurable levels
- | **Transmission Interval** – Period at which to transmit the advertisement. 10ms accuracy
- | **Connectable/Non-connectable** Advertisement which describe a device which can be connected to or a device which cannot be connected to.
- | **MAC address** – MAC address of the specific advertisement can be set. Note changing the MAC address to anything other than the default address used at the factory means that the address cannot be guaranteed by EM to be unique in the installation area.

6.1.4. REAL TIME CLOCK

A real time clock is available from the microcontroller with an accuracy of 150ppm. The EMBE01 standard firmware uses this clock for timing of the advertisements. It can be modified to add a service for synchronizing this clock with an external clock.

6.2. PACKET CONTENTS

The Bluetooth advertising packets are undirected advertising events which follow the GAP specification according to the Bluetooth Specification V4.0, Volume 3, Part C, Section 11.

Packets follow the definitions defined in the *Beacon Packet Definition Specification*.

7. LABEL

The label is installed inside the front housing and has the following contents:

- | Model: EMBE01
- | Unique Serial Number
- | FCC-ID: 2ACQR-EMBE01
- | IC ID: 12155A-EMBE01
- | FCC and CE Marking
- | Major ID/Minor ID
- | EM Microelectronic company name
- | QR Code containing the unique Serial Number/Major ID/Minor ID

The serial number is generated by reading the device address of EMBE01, reversing the byte order, and printing the number in decimal form. For example:

- | Device Address: 0x0CF3EE5A0001 corresponds to Serial Number: 001101037237004

8. PACKING AND LABELING

EMBE01 beacons are sorted in cardboard box with cardboard separators

- | There are two levels of 30 parts in one box for the total of 60 parts per box.
- | Box size = 44.4 x 34.2 x 26.0 cm (L x W x H).

A label is applied on each box. The minimum information on the label is the following:

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

9. ENVIRONMENTAL RESPONSIBILITY

9.1. RESTRICTION OF HAZARDOUS SUBSTANCES (ROHS)

EMBE01 (EM Product) is compliant with the EU RoHS Directive 2015/863/EU (European Directive on the Restriction of the Use of Certain Hazardous

Substances in Electrical and Electronic Equipment). Substances under ban (2015/863/EU) must not exceed the following values:

- | 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

9.2. 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) at

<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.

9.3. 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 Directive.

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), after removing the batteries.

Specifics on battery

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.

