



**PLUS Modular Tag
Model 2111
Circuit Implementation**

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Intended Use	This document examines the PLUS 2111 Modular Tag. This document is intended for PLUS Location Systems internal use only.
FCC Compliance	<p>U.S. Operation: This device complies with Part 15 of the FCC Rules. Operation is subject to the following 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. (3) Operation on board an aircraft or a satellite is prohibited. (4) Devices operating under this section may not be employed for the operation of toys. (5) Except for operation onboard a ship or a terrestrial transportation vehicle, the use of a fixed outdoor infrastructure is prohibited. A fixed infrastructure includes antennas mounted on outdoor structures, e.g., antennas mounted on the outside of a building or on a telephone pole. This outdoor infrastructure prohibition applies to intentional ultra-wideband (UWB) emitters.</p> <p>Operation in disregard of these conditions is a violation of 47 U.S.C. 301 and could subject the operator to serious legal penalties. Disassembling or modifying the unit will void both FCC compliance and PLUS[®] Location Systems warranty provisions.</p>
Manufacturer Contact Information	<p>HQ and Regulatory Responsibility: PLUS Location Systems USA, LLC 6767 Old Madison Pike NW, Suite 310 Huntsville, AL 35806 www.pluslocation.com</p>

Safety Information

Read and follow all instructions before using the **Model 2111 Tag** when it has been incorporated into an end product. The following are typical safety instructions for a PLUS Tag that would apply to an end product using the 2111 Module.

- Do not use the Tag if it has been damaged.
- Do not install in environments that exceed temperature and humidity requirements.
- Do not leave the Tag on a heat source.
- Never open the case on the Tag: There are no user serviceable parts or replaceable parts inside the enclosure.

Revisions to this Document

Version	Comments	Release Date
Rev A	Initial release	03/10/2015

Introduction

The Plus Model 2111 Modular Tag is a complete PLUS UWB Tag design for integration into a PLUS printed wiring assembly (PWA) and enclosure, and connected to a power source. It has the following features:

- Runs from a 3 volt DC power source (can operate down to 2 volts DC)
- Will transmit a UWB packet at a rate set at time of manufacture. Rate can be set to 1Hz, 6Hz, 8Hz, 10Hz, 15Hz or 20Hz.
- Meets FCC Section 15.212, rules concerning single modular transmitters.
- Certified to comply with FCC Part 15.519

Overview

Background

Tag tracking is accomplished by analyzing time-differences-of-arrival (TDOAs) of tag transmissions. When a tag transmits a packet, PLUS[®] Sensors that successfully receive the packet will send out information concerning the tag packet, including a precise timestamp. The difference in the timestamp between sensors gives the TDOA for that sensor pair/tag combination. At least three sensors must hear a tag in order to determine a valid position for that tag.

Model 2111 Modular Tag

The 2111 Modular Tag allows the implementation of a controlled and defined UWB transmitter onto a PWA, provided the specifications in the PLUS documentation with regards to PWB layout, board material, component sources and values, and assembly of the 2111 Tag circuitry are followed.

The 2111 Tag is a small transmit only device with an active transmit duty cycle of less than 0.0026%. The Tag has one integrated antenna optimized for vertical applications. The data packets include a tag identification code, status information, and time of arrival data. The FCC ID is ZEH0215.

As mentioned in the introduction, the data packet rate can be set at manufacture to 1Hz, 6Hz, 8Hz, 10Hz, 15Hz, or 20Hz. This is done by selection of the value of one part and is identified in a table in the schematic.

PLUS Documentation:

The controlling PLUS documentation for the 2111 Modular Tag is:

- 300-0220A, PWB, 2111 TAG Module
- 200-0260A PWA, 2111 TAG Module

The PWB document controls the layout of the 2111Tag printed circuit board, hence the antenna and transmitter, and it defines the printed circuit board parameters including board material and thickness.

The PWA document defines the connections of the 2111 Tag board circuitry and the AVL for all the components. The PWA also contains the block diagram for the 2111 Tag.

Specifications

Housing Material	Housing design varies to meet end user requirements. Housing material will vary and may include ABS, Polycarbonate, HDPE, Silicone, or Rubber.
Power Source	3V DC (can work down to 2V DC)
Ingress Protection	Dependent on User enclosure design
Compliance	FCC Part 15 15.519(3)(c) / 15.209 15.519(3)(d) 15.519(3)(b) 15.519 (c) 15.519 (e) EU Standard EN 302 500-1 v2.1.1 (2010-10) EN 302 500-2 v2.1.1 (2010-10) EN 301 489-33 v1.1.1 EN 301 489-1 v1.9.2 FCC ID ZEH0215 RoHS
Temperature	Typical Operating: -20°C to +55°C Typical Storage: -30°C to +60°C
Relative Humidity	Up to 95% non-condensing
Model Number	2111

Mounting

Depending on end user requirements, mounting methods will vary.

Identification

Per FCC Section 15.212: The 2111 Tag FCC identification (ID) will be printed via the silkscreen on the bottom side of the board.

Figure 1-1 below shows the FCC ID as it appears on the bottom of the board right above the PLUS copyright and PWB identification:

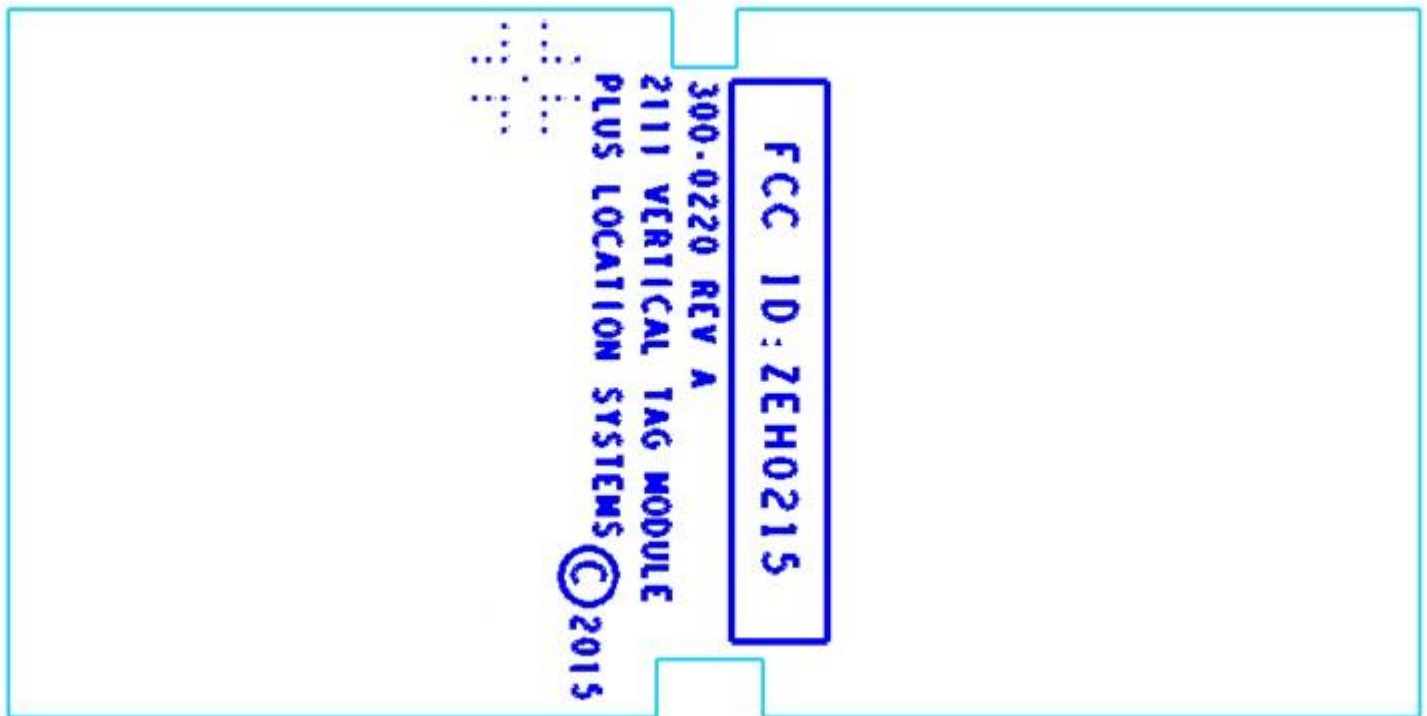


Figure 1-1

FOR THE USER IMPLEMENTATION OF THE 2111 TAG:

Per FCC Section 15.212: The FCC identification (ID) information for the 2111 Modular Tag must be visible on the End product. The information must include product model number and the statement “CONTAINS FCC ID ZEH0215”. Other information such as a unique serial number is encouraged but is not a requirement. PLUS document 320-0305 provides a template for required information and layout for the End Product ID label.

FCC Section 15.212 Compliance

The PLUS 2111 Tag complies with FCC Section 15.212 rules concerning single modular transmitters in the following:

15.212 (a)

REQUIREMENT:

“Single modular transmitters consist of a completely self-contained radiofrequency transmitter device that is typically incorporated into another product, host or device. Split modular transmitters consist of two components: a radio front end with antenna (or radio devices) and a transmitter control element (or specific hardware on which the software that controls the radio operation resides). All single or split modular transmitters are approved with an antenna. All of the following requirements apply, except as provided in paragraph (b) of this section.”

IMPLEMENTATION:

The 2111 Modular Tag consists of a microcontroller (also referred to as the processor) with timing controlled by a crystal, a burst mode oscillator transmitter, and an antenna. There is also a connection provided for an external 3 volt battery.

The microcontroller wakes up at one of 6 preset time intervals set by a component at the time of manufacture: 1, 6, 8, 10, 15, or 20 times a second. When the microcontroller wakes up, it turns on the rest of the Tag circuitry, then calculates and sends a packet of multiple bits spaced 500nS apart to key the transmitter. The transmitter generates a single UWB burst for each logic 1 of digital data presented to it. The transmitter then sends the UWB burst to the antenna.

When done, the microcontroller sets the rest of the Tag circuitry on the 2111 to power down, goes back into its sleep mode, and waits until the set time interval is reached again to wake-up and repeat the process.

The 2111 Module Tag documentation defining the layout, board material, circuitry, and components, is defined in PLUS documentation:

- 300-0220A, PWB, 2111 TAG Module
- 200-0260A PWA, 2111 TAG Module.

15.212 (a) (1) (i)

REQUIREMENT:

Shielding of radio elements:

IMPLEMENTATION:

See 15.212 (b), limited modular approval.

15.212 (a) (1) (ii)

REQUIREMENT:

“The modular transmitter must have buffered modulation/data inputs (if such inputs are provided) to ensure that the module will comply with part 15 requirements under conditions of excessive data rates or over-modulation.”

IMPLEMENTATION:

The 2111 Tag circuitry transmitter drive from the microcontroller is a logic gate providing a fixed drive that will not overdrive the burst mode oscillator transmitter. The data rate to the transmitter is fixed from the microcontroller by software and the crystal time base. The modulation is set by the microcontroller and transmitter as simple on/off keying. The transmitter generates a UWB burst pulse whenever the microcontroller clocks a logic high ON pulse to the transmitter input.

15.212 (a) (1) (iii)

REQUIREMENT:

Power supply regulation of the modular transmitter:

IMPLEMENTATION:

See (b), limited modular approval

15.212 (a) (1) (iv)

REQUIREMENT:

“The antenna must either be permanently attached or employ a ‘unique’ antenna coupler (at all connections between the module and the antenna, including the cable)”.

IMPLEMENTATION:

The antenna on the 2111 Module is part of the PWB layout hence will be permanently attached to the transmitter.

15.212 (a) (1) (v)

REQUIREMENT:

“The modular transmitter must be tested in a stand-alone configuration, *i.e.*, the module must not be inside another device during testing for compliance with part 15 requirements. Unless the transmitter module will be battery powered, it must comply with the AC line conducted requirements found in §15.207. AC or DC power lines and data input/output lines connected to the module must not contain ferrites, unless they will be marketed with the module (see §15.27(a)).”

IMPLEMENTATION:

The 2111 Modular Tag was tested at the compliance test facility in the stand-alone configuration as defined above. It was powered by a 3 volt DC power source connected directed to the module with no ferrites.

15.212 (a) (1) (vi)

REQUIREMENT:

“The modular transmitter must be equipped with either a permanently affixed label or must be capable of electronically displaying its FCC identification number.”

IMPLEMENTATION:

The 2111 Tag PWB will contain the FCC identification number of the 2111 Module in the silkscreen. See IDENTIFICATION section of this document.

15.212 (a) (1) (vi) (A)

REQUIREMENT:

“If the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains Transmitter Module FCC ID: XYZMODEL1” or “Contains FCC ID: XYZMODEL1.” Any similar wording that expresses the same meaning may be used.”

IMPLEMENTATION:

The final product which contains the 2111 Module will be labeled or marked to indicate that it contains FCC ID ZEH0215. Refer to PLUS drawing 320-0305 for recommended format.

15.212 (a) (1) (vi) (B)

REQUIREMENT:

Electronic display of FCC identification number.

IMPLEMENTATION:

Not applicable, since the 2111 Modular Tag will not be installed in any product that has an electronic display.

15.212 (a) (1) (vii)

REQUIREMENT:

“The modular transmitter must comply with any specific rules or operating requirements that ordinarily apply to a complete transmitter and the manufacturer must provide adequate instructions along with the module to explain any such requirements. A copy of these instructions must be included in the application for equipment authorization”

IMPLEMENTATION:

These instructions will be included as a user’s manual with any upward product the 2111 Tag module will be integrated into. i.e.: The instructions for the current PLUS Tags will apply to products incorporating the 2111 Tag module.

15.212 (a) (1) (viii)

REQUIREMENT:

“The modular transmitter must comply with any applicable RF exposure requirements in its final configuration”

IMPLEMENTATION:

See all tests the 2111 Tag is compliant with under Section 15.212 (b).

15.212 (a),(2), (i),(ii),(iii), and (iv)

REQUIREMENT:

Split modular system.

IMPLEMENTATION:

The 2111 Module is not a split modular system so 15.212 (a) (2) sections (i),(ii),(iii), and (iv) do not apply.

15.212 (b)

REQUIREMENT:

“Limited modular approval also may be granted in those instances where compliance with RF exposure rules is demonstrated only for particular product configurations. The applicant for certification must state how control of the end product into which the module will be installed will be maintained such that full compliance of the end product is always ensured.”

IMPLEMENTATION:

The 2111 Modular Tag will:

- Not have shielding over the radio elements of the circuitry; 15.212 (a) (1) (i)
- Not have regulation of its power supply (It operates from an unregulated 3V DC power source). ; 15.212 (a) (1) (i)

Control of the end product is achieved by the circuit design. Besides the 3V power source for the Tag, the 2111 circuitry is self-contained with no external circuit interface, so the microprocessor maintains the drive to the transmitter, and the transmitter maintains the drive to the antenna.

Consequently, the 2111 Tag Module will apply for limited modular approval.

In compliance testing, the 2111 Tag with no shielding of the radio elements or regulation of the power supply was compliant with:

- 15.519 (3) (c) / 15.209
- 15.519 (d)
- 15.519 (3) (b)
- 15.519 (3)(e)
- 15.519 (3)(e)

Example

Figure 1-2, below, shows an example of a 2111 Module integrated onto a PWA for potential use in an end product. This example is one of several possible PWA's PLUS could put the 2111 Modular TAG circuitry per the controlling PLUS documentation.

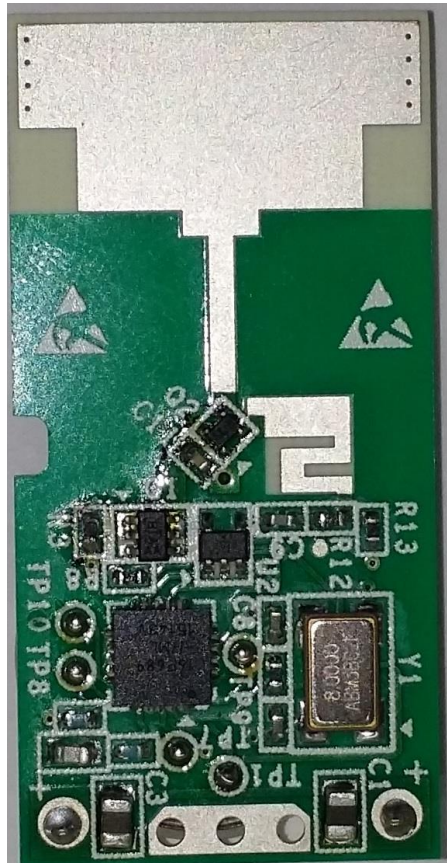


Figure 1-2.

End Product ID Recommended Format

The PLUS drawing, 320-0305, that has the recommended format for the label that would include the 2111 FCC ID number, is presented below for information.

