Resolution Products, Inc.

REHP1AZ0 Panel Replacement Module

FCC ID: U5X-REHP1AZ0

Certification Test Report

FCC Part 15.247

March 1, 2018

Contents

1. Introduction

The REHP1AZ0 Panel Replacement Module (PRM) is a hardwire to wireless sensor translation module. Hardwired sensors wire into the PRM's screw terminal inputs and the REHP1AZ0 converts the inputs into packets that get transmitted through one of the two printed antennas, either an Inverted-F trace antenna or a fractal trace antenna. The transmitted signal follows the wireless 2.4GHz Zigbee® protocol and communicates with a Zigbee security panels. The unit is externally powered from a 110VAC to 12VDC transformer and has a 12VDC battery backup. The unit measures 10.25" x 7.875" x 3.25" and weights 29.2oz. without the battery, 97.2oz. with the battery.

The REHP1AZ0 consists of a Microchip PIC16 processor to handle the I/O from the hardwire zone inputs and a Zigbee EM3585 SoC to handle the RF output. When one of the 8 possible sensors/zones are triggered, the PIC processor converts the input signal into a packet that the Zigbee security panel can understand. One packet is transmitted for each trigger from any zone. The PRM then requires a ACK reply message from the security panel. In the absence of zone activity, the PRM transmits one supervisory packet to maintain a connection with the Zigbee security panel. Supervisory packets also require a ACK reply message.

The transmitter circuit is contained in the Zigbee EM3585 SoC which is specifically designed for Zigbee networks. This system-on-chip contains an ARM® Cortex™-M3 processor, an IEEE 802.15.4 compliant transceiver, memory, and multiple peripherals. The EM3585 SoC also contains the Zigbee Alliance stack which formats packets according to the Zigbee protocol and allows the REHP1AZ0 to communicate with other Zigbee devices using O-QPSK modulation. The RF signal is then radiated through one of trace antennas located on the board.

Certification is requested under FCC Rules, Part 15, Subpart C, Paragraph 15.247.

2. Statement of Compliance

Specific sections of FCC Rules Part 2 that require information or listing are given below.

2.1. FCC Part 2 §2.907

This is an application for certification of original equipment

2.2. FCC Part 2 §2.911

a) This application has been filed electronically using form 731.
b) All required information has been supplied in this application and its attachments.
c) This application has been electronically signed by an officer of Resolution Products, Inc.
d) The technical test data has been signed by the agency performing the testing.
e) Signature supplied in appropriate block on form 731.
f) Processing fee has been paid.
g) Signatures have been supplied electronically.

2.3. FCC Part 2 §2.913

a) This application has been filed electronically.
b) Appropriate fees have been filed electronically.
c) Equipment samples shall be supplied as requested.

2.4. FCC Part 2 §2.915

We are requesting a grant of certification. This application shows compliance with the technical standards.

2.5. FCC Part 2 §2.925

A label shall be affixed to each piece of equipment, showing the FCC identifier. The label shall read "FCC ID: U5X- REHP1AZ0". See Exhibit B for a photograph showing the label and location on the device.

2.6. FCC Part 2 §2.943, 2.945

Sample production equipment shall be submitted to the FCC upon request.

2.7. FCC Part 2 §2.947

a) Measurement procedure follows ANSI C63.4: 2009.
b) A description of utilized test equipment is contained in the report.

2.8. FCC Part 2 §2.948

Measurements were taken at the following FCC-approved facility:

Rhein Tech Laboratories, Inc.
360 Herndon Parkway, Suite 1400
Herndon, VA 20170 USA
Contact: Rick McMurray
703-689-0368

Photographs of the test site are shown in Exhibit J.

2.9. FCC Part 2 §2.1033

a) Form 731 has been filed electronically.
b) The technical report, along with its exhibits, contains the information as follows:

(1) The full name and mailing address of the manufacturer of the device and the applicant for certification:

Resolution Products, Inc.
1402 Heggen St.
Hudson, WI 54016

(2) FCC Identifier: U5X-REHP1AZ0
(3) A copy of the installation/user instructions is furnished as Exhibit E.
(4) A brief description of the device and operation is furnished in Exhibit F. Schematic is furnished in Exhibit G.
(5) Block diagram furnished in Exhibit H.
(6) This document constitutes a technical test report.
(7) Internal and external photographs have been furnished in Exhibits A and C.
(8) Not applicable. There are no peripheral or accessory devices used with this device. It is a standalone device.
(9) This application not pursuant to the transition rules of section 15.37
(10) Not applicable. This device does not include a scanning receiver.
(11) Not applicable.
(12) Not applicable.
(13) Not applicable.
(14) Test setup photos are furnished in Exhibit J.

c) Not applicable. This device shall operate under Part 15 of the rules.
d) Not applicable.
e) Not applicable. This is not a composite system.

3. Discussion of Laboratory Measurements and Rules Compliance

3.1. FCC Part 15 §15.203, §15.247(b)(4)

A printed omnidirectional Inverted-F antenna and printed omnidirectional Fractal antenna share the same PCB board as the rest of the circuit on the REHP1AZ0 and, therefore, are permanently attached. In addition, the directional gain of these antennas does not exceed the 6dBi limit required by FCC §15.247(b)(4). An image of the two antennas can be seen in Exhibit C.

3.2. FCC Part 15 §15.207

Conducted line emissions were found compliant with FCC requirement §15.207. Details can be found on page 18 in Exhibit I.

3.3. FCC Part 15 §15.247(a)(2)

The REHP1AZ0 model PRM operates using digital modulation in the 2400-2483.5MHz range which requires a minimum 6dB bandwidth of 500kHz, per FCC §15.247(a)(2). This requirement is meet as shown in the table below. Further details can be seen on pages 10-12 in Exhibit I.

Center Frequency	6dB Bandwidth	Minimum	Result
2405 MHz	1.606 MHz = 1606 kHz	500 kHz	Pass
2440 MHz	1.576 MHz = 1576 kHz	500 kHz	Pass
2475 MHz	1.570 MHz = 1570 kHz	500 kHz	Pass

3.4. FCC Part 15 §15.247(b)(3)

Systems using digital modulation in the 2400-2483.5 MHz bands are allowed 1-Watt maximum peak conducted output power. Since the omnidirectional antennas are fixed to the EUT, the radiated emissions were taken instead of direct output power. The 1-Watt power limit was converted to an emission limit at 3 meters using a gain (G_t) of 0dBi ($G_t = 1$),

$$E_{V/m} = \frac{\sqrt{30 P_t G_t}}{d} = \frac{\sqrt{30(1W)(1)}}{(3m)} = 1.825\ V/m$$

$$E_{\mu V/m} = 1825000\ \mu V/m$$

$$E_{dB\mu V/m} = 20\log(1825000\ \mu V/m) = 125.2\ dBuV/m$$

The average emission levels compared to the emission limits for each antenna at all three frequencies can be seen in the table below. Further details can be seen in Exhibit I. The average emission levels are based on a duty cycle correction factor of 12.4dB. The worst-case emission in a 100ms window is 12 packets, were each packet is 2ms in length.

$$\frac{(12)(2ms)}{100ms} = 24\%\ duty\ cycle \rightarrow 20\log(0.24) = -12.4\ dB$$

Inverted-F Antenna			
Frequency (MHz)	Average Emission Level (dBµV/m)	Limit (dBµV/m)	Result
2405	99.3	125.2	Pass
2440	100.8	125.2	Pass
2475	100.5	125.2	Pass

Fractal Antenna			
Frequency (MHz)	Average Emission Level (dBµV/m)	Limit (dBµV/m)	Result
2405	97.6	125.2	Pass
2440	98.1	125.2	Pass
2475	99.5	125.2	Pass

3.5. FCC Part 15 §15.247(d), §15.209

All spurious emissions for the REHP1AZ0 must be attenuated by at least 20dB below the fundamental emission level required by §15.247(d). In addition, the emissions that fall into restricted bands, outlined in §15.205(a), must comply with emission limits specified by §15.209(a).

The table below shows the measurable spurious emission frequencies for the REHP1AZ0 and their applicable restricted frequency bands.

Measurable Spurious Signal Frequencies	Applicable Spurious Emission Frequency Bands
4810 MHz = 4.81 GHz	4.5-5.15 GHz
4880 MHz = 4.88 GHz	
4950 MHs = 4.95 GHz	
7320 MHz = 7.32 GHz	7.25-7.75 GHz
7425 MHz = 7.425 GHz	
12025 MHz = 12.025 GHz	7.25-7.75 GHz
12200 MHz = 12.2 GHz	
12375 MHz = 12.375 GHz	
19240 MHz = 19.24 GHz	17.1-21.4 GHz
19520 MHz = 19.52 GHz	
19800 MHz = 19.8 GHz	
22275 MHz = 22.275 GHz	22.01-23.12 GHz

The §15.209(a) limit that applies to the frequency ranges in the above table are for frequencies above 960MHz, which is limited to 500µV/m or 54dBµV/m. The tables below compare the spurious emissions to the restricted band limits for each antenna. Further details on the spurious emissions can be seen in Exhibit I.

Inverted F Antenna Worst Case Spurious Emissions

Spurious Frequency (MHz)	Peak Emission Level (dBuV/m)	Peak Limit (dBuV/m)	Average Emission Level (dBuV/m)	Average Limit (dBuV/m)	Result
4810	23.0	74.0	10.6	54.0	Pass
4880	55.0	74.0	36.5	54.0	Pass
4950	55.4	74.0	37.1	54.0	Pass
7320	54.7	74.0	35.2	54.0	Pass
7425	54.6	74.0	35.2	54.0	Pass
12025	58.3	74.0	45.9	54.0	Pass
12200	46.5	74.0	21.4	54.0	Pass
12375	57.5	74.0	34.3	54.0	Pass
19240	59.1	74.0	46.7	54.0	Pass
19520	60.4	74.0	37.5	54.0	Pass
19800	56.3	74.0	30.9	54.0	Pass
22275	60.5	74.0	36.8	54.0	Pass

Fractal Antenna Worst Case Spurious Emissions

Spurious Frequency (MHz)	Peak Emission Level (dBuV/m)	Peak Limit (dBuV/m)	Average Emission Level (dBuV/m)	Average Limit (dBuV/m)	Result
4810	23.8	74.0	11.4	54.0	Pass
4880	55.9	74.0	43.5	54.0	Pass
4950	54.6	74.0	42.2	54.0	Pass
7320	60.5	74.0	48.1	54.0	Pass
7425	56.2	74.0	43.8	54.0	Pass
12025	46.9	74.0	34.5	54.0	Pass
12200	55.1	74.0	42.7	54.0	Pass
12375	48.1	74.0	35.7	54.0	Pass
19240	66	74.0	53.6	54.0	Pass
19520	65.1	74.0	52.7	54.0	Pass
19800	58.3	74.0	45.9	54.0	Pass
22275	58.3	74.0	45.9	54.0	Pass

In addition, the lower band edge of 2.405GHz and the upper band edge of 2.475GHz were measured to ensure compliance with emission limits required by §15.209(a). The table below shows that the band edges and compliant. Further details on the band edge limits can be seen in Exhibit I.

Antenna	Fundamental Frequency (MHz)	Closest Restricted Band (MHz)	Closest Band Edge	Emission Level (dB)	Limit (dBµV/m)	Margin (dB)	Result
Inverted-F	2405	2310-2390	Lower	41.3	54.0	12.7	Pass
	2475	2483.5-2500	Upper	49.9	54.0	4.1	Pass
Fractal	2405	2310-2390	Lower	40.3	54.0	13.7	Pass
	2475	2483.5-2500	Upper	48.8	54.0	5.2	Pass

3.6. FCC Part 15 §15.247(e)

Digitally modulated systems power spectral density cannot be greater than 8dBm in any 3kHz band during continuous transmission according to §15.247(e). The table below shows that the REHP1AZ0 power spectral density measured with a resolution bandwidth of 3kHz is below this limit. Further details can be seen on pages 13-15 in Exhibit I.

Frequency (MHz)	Power Spectral Density (dBm)	Limit (dBm)	Result
2405	2.6	8	Pass
2440	1.7	8	Pass
2475	1.3	8	Pass