LSR
a Laird Business
ACCREDITED
TESTING CERT #1255.01
W66 N220 Commerce Court ● Cedarburg, WI 53012
Phone: 262.375.4400 ● Fax: 262.375.4248
www.lsr.com

# RF Evaluation Exclusion Exhibit For:

# Halo/Halo+

Prepared by:

Shane Dock, EMC Engineer I

12-12-16

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## Product Description:

Halo and Halo+ are both Dual-Principal Smoke and Carbon Monoxide ("CO") Alarms that utilize a 120 VAC Mains connected primary power source with a non-user serviceable battery backup as a secondary power source. Halo and Halo+ both have 2.4 GHz WLAN send and receive wireless connectivity and 2.4 GHz ZigBee send and receive wireless connectivity. Halo+ comes with a National Oceanic and Atmospheric Administration ("NOAA") All Hazards Weather Receiver Integrated Circuit ("IC") and associated antenna. The Weather Receiver IC is receive only and does not have transmit functionality. Halo and Halo+ are both designed to detect hazardous levels of Smoke and CO, are intended for open area protection in indoor locations of residential units, and are equipped with visual and audible alarm indicators. Also integrated into the design is an alarm silencing feature, a smart-device application ("App") remote control receiver for Testing and silencing, and a low battery indicator with silence functionality.

## Associated Antenna(s):

The antenna associated with the EUT is a chip antenna manufactured by Taiyo Yuden, model number AH316M245001-T. This antenna has a peak gain of 1.9 dB.

## Statement of compliance:

The EUT was evaluated against the requirements and limits of OET Bulletin 65, KDB 447498 and was found to be compliant.

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## Limits:

Mobile (MPE)

OET Bulletin 65 limits for General population/Uncontrolled Exposure

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) ($mW/cm^2$) | Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes) |
|---|---|---|---|---|
| 0.3-1.34 | 614 | 1.63 | (100)* | 30 |
| 1.34-30 | 824/f | 2.19/f | $(180/f^2)$* | 30 |
| 30-300 | 27.5 | 0.073 | 0.2 | 30 |
| 300-1500 | -- | -- | f/1500 | 30 |
| 1500-100,000 | -- | -- | 1.0 | 30 |

f = frequency in MHz *Plane-wave equivalent power density

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# Data and calculations:

WLAN:

802.11b

| Data Rate | Channel | Pout (dBm) | Corrected Pout (dBm) |
|---|---|---|---|
| 1 MBPS | Low | 7.436 | 9.148 |
| | Mid | 8.096 | 9.808 |
| | High | 8.430 | 10.142 |
| 11 MBPS | Low | 6.192 | 9.740 |
| | Mid | 6.662 | 10.210 |
| | High | 6.899 | 10.447 |

802.11g and 802.11n

| Data Rate | Channel | Pout (dBm) |
|---|---|---|
| 6 MBPS | Low | 15.605 |
| | Mid | 17.606 |
| | High | 16.435 |
| 54 MBPS | Low | 10.217 |
| | Mid | 12.480 |
| | High | 11.529 |
| MCS0 | Low | 14.574 |
| | Mid | 16.408 |
| | High | 15.435 |
| MCS7 | Low | 8.751 |
| | Mid | 11.213 |
| | High | 10.020 |

Zigbee:

| Channel | Pout (dBm) |
|---|---|
| 11 | 17.486 |
| 12 | 18.559 |
| 18 | 13.522 |
| 24 | 14.755 |
| 25 | 8.366 |

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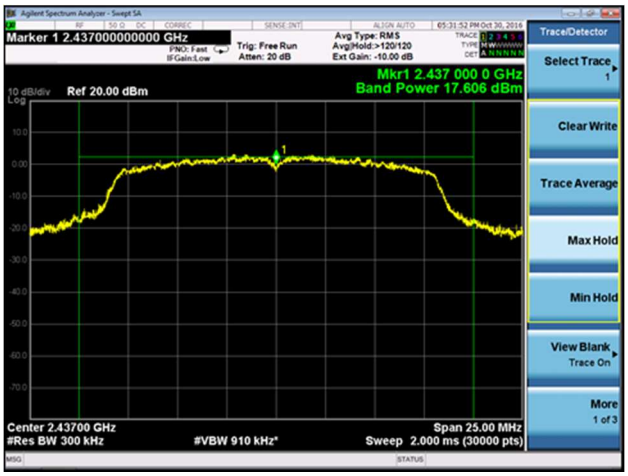
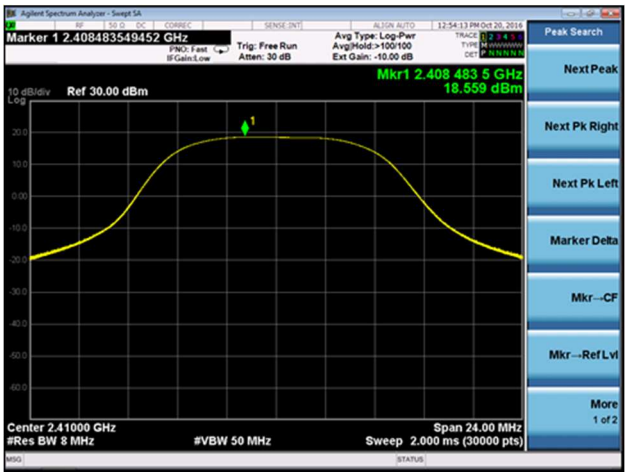
# Screen Capture of maximum output power

## WLAN




Frequency 2437 MHz; 6 MBPS

## Zigbee




Frequency 2408 MHz

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# A. MPE Calculation

## WLAN

The following MPE calculations are based on a measured conducted RF power of +17.6 dBm as presented to the antenna. The peak gain of this antenna, based on the data sheet is +1.9 dBi. An additional 1 db of production tolerance is included.

**Prediction of MPE limit at a given distance**

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

| | | |
|---|---|---|
| Maximum peak output power at antenna input terminal: | 18.61 | (dBm) |
| Maximum peak output power at antenna input terminal: | 72.611 | (mW) |
| Antenna gain(typical): | 1.9 | (dBi) |
| Maximum antenna gain: | 1.549 | (numeric) |
| Prediction distance: | 20 | (cm) |
| Prediction frequency: | 2437 | (MHz) |
| MPE limit for uncontrolled exposure at prediction frequency: | 1 | (mW/cm^2) |

| | | |
|---|---|---|
| Power density at prediction frequency: | 0.022373 | (mW/cm^2) |
| Maximum allowable antenna gain: | 18.4 | (dBi) |
| Margin of Compliance at 20 cm = | 16.5 | dB |

Power Density = **0.0224 mW/cm$^2$** = **0.224 W/m$^2$**

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**RF Exposure Evaluation:**

Evaluated against exposure limits: General Public Use ☒ Controlled Use ☐
Duty cycle used in evaluation: 100 %
Standard(s)/Procedure(s) used for evaluation (e.g. IEEE C95.3):OET Bulettin 65 and RSS 102
Measurement distance: 20 cm
RF field strength value: **0.224** V/m ☐ A/m ☐ W/m² ☒
Measured ☐ Computed ☐ Calculated ☒

## Zigbee

The following MPE calculations are based on a measured conducted RF power of +18.6 dBm as presented to the antenna. The peak gain of this antenna, based on the data sheet is +1.9 dBi. An additional 1 db of production tolerance is included.

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**Prediction of MPE limit at a given distance**

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

| | | |
|---|---|---|
| Maximum peak output power at antenna input terminal: | 19.60 | (dBm) |
| Maximum peak output power at antenna input terminal: | 91.201 | (mW) |
| Antenna gain(typical): | 1.9 | (dBi) |
| Maximum antenna gain: | 1.549 | (numeric) |
| Prediction distance: | 20 | (cm) |
| Prediction frequency: | 2408 | (MHz) |
| MPE limit for uncontrolled exposure at prediction frequency: | 1 | (mW/cm^2) |

| | | |
|---|---|---|
| Power density at prediction frequency: | 0.028102 | (mW/cm^2) |
| Maximum allowable antenna gain: | 17.4 | (dBi) |
| Margin of Compliance at 20 cm = | 15.5 | dB |

Power Density = **0.0281 mW/cm$^2$** = **0.281 W/m$^2$**

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## RF Exposure Evaluation:

Evaluated against exposure limits: General Public Use ☒ Controlled Use ☐
Duty cycle used in evaluation: 100 %
Standard(s)/Procedure(s) used for evaluation (e.g. IEEE C95.3):OET Bulettin 65 and RSS 102
Measurement distance: 20 cm
RF field strength value: **0.281** V/m ☐ A/m ☐ W/m² ☒
Measured ☐ Computed ☐ Calculated ☒

## Combined Values:

The below calculation sums the effect of both radios transmitting in unison.

$$\sqrt{\left(\frac{Szigbee}{MPE\ Limit\ @\ Frequency}\right)^2 + \left(\frac{Swlan}{MPE\ Limit\ @\ Frequency}\right)^2} \quad \leq \quad 1.0$$

Where Szigbee = .281, Swlan = .224, and the MPE Limit is 1.

Square root of [ (.281/1)^2 + (.224/1)^2) = .3593 W/m2 which is less than 1.

## Summary:

The calculated power density of the EUT was found to be below the OET Bulletin 65 MPE limit.