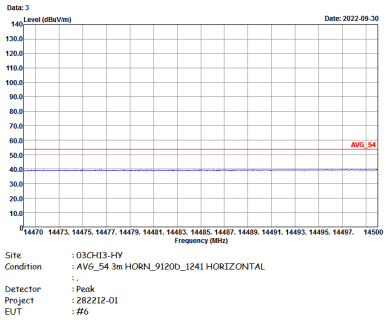
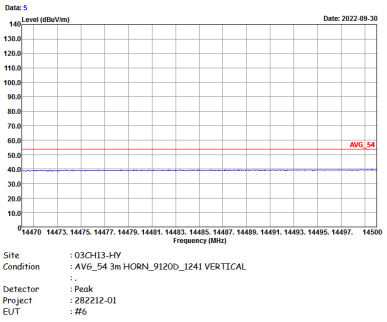
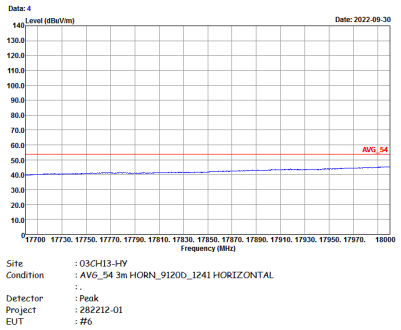
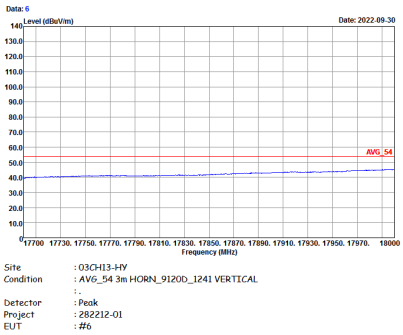
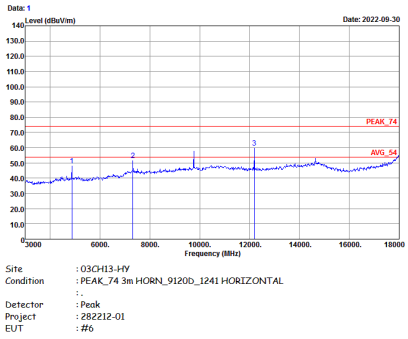
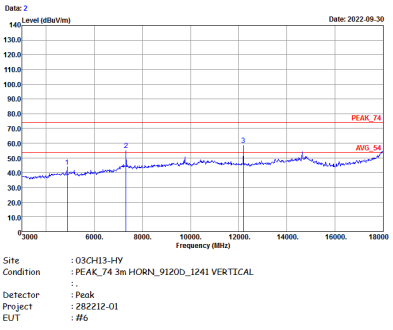
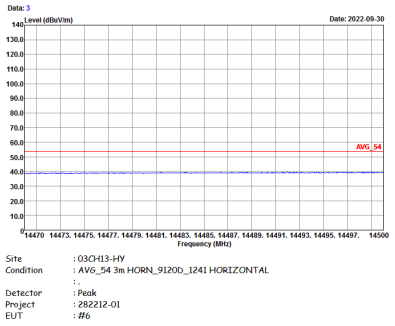
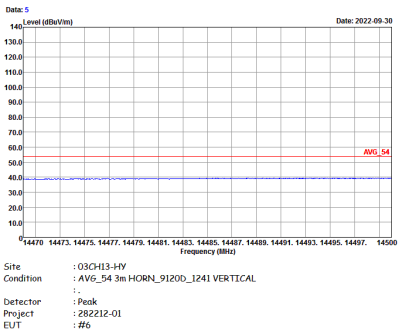
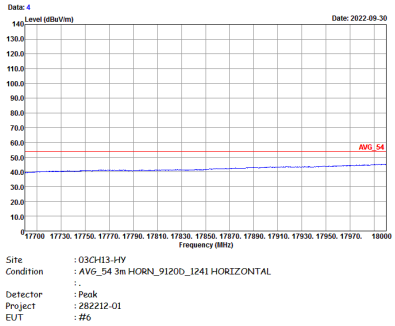
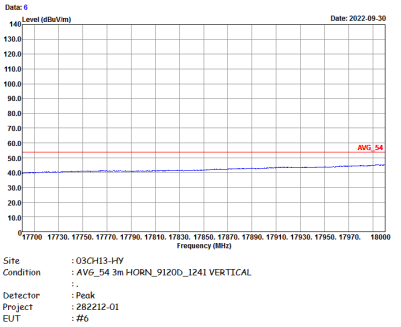
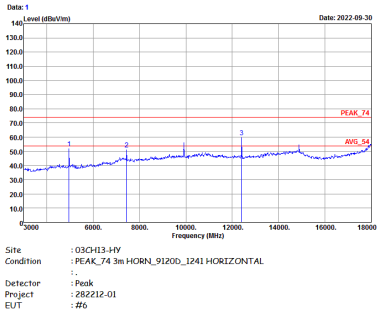
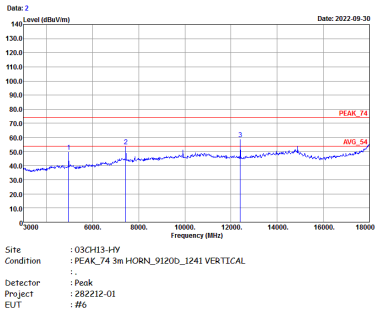
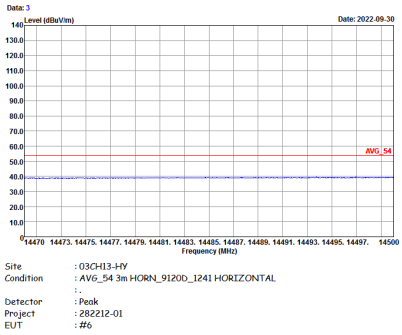
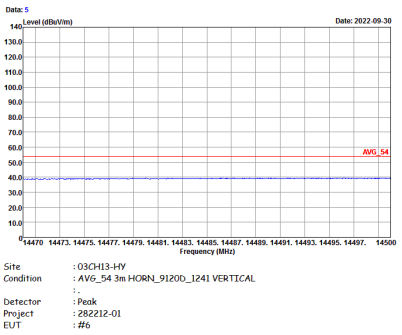
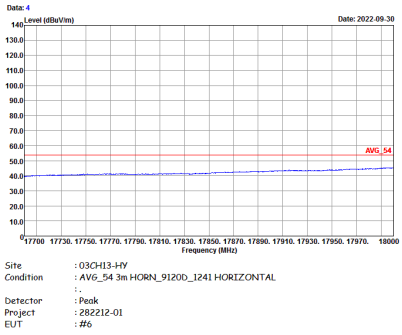
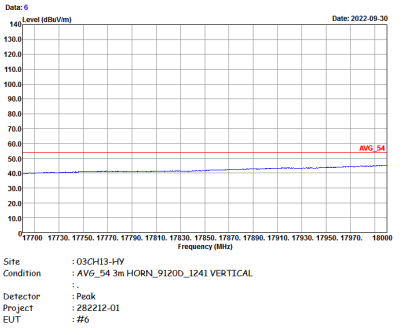
BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Vertical
14.47G ~14.5G Avg.		
17.7G ~18G Avg		

BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH19 2440MHz	
	Horizontal	Vertical
Peak Avg.		

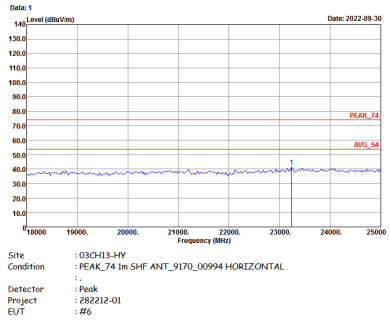
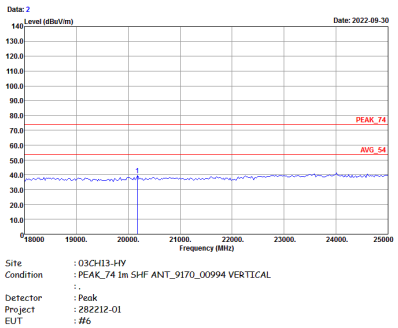
BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH19 2440MHz	
	Horizontal	Vertical
14.47G ~14.5G Avg.		
17.7G ~18G Avg		

BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Vertical
Peak Avg.		

BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Vertical
14.47G ~14.5G Avg.		
17.7G ~18G Avg		

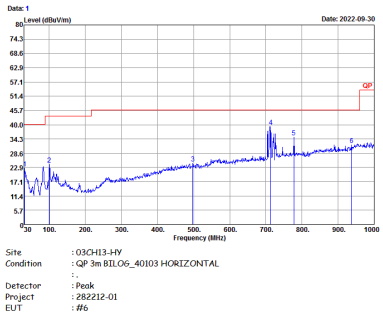
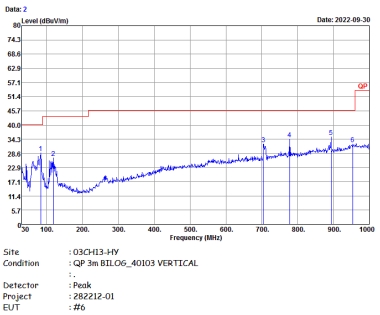
Emission above 18GHz

2.4GHz BLE (SHF @ 1m)

BLE	2.4GHz 2400~2483.5MHz	
	BLE SHF	
	Horizontal	Vertical
Peak Avg.		

Emission below 1GHz

2.4GHz BLE (LF)

BLE	2.4GHz 2400~2483.5MHz	
	BLE LF	
	Horizontal	Vertical
QP / Peak		

Appendix E. Supplier Declaration of Conformity

1900 S Norfolk St, ST#310, San Mateo, CA 94403

Tile Operational Description

Prepared by: Muhammad Umair / Riddhi Patel Date: August 26, 2022

Overview:

Tile devices utilize a location transceiver. The device uses Atmosic ATM2202SR-001 Bluetooth Low Energy chipset. The IC is Bluetooth © core specification 5.0 compliant, because it is Bluetooth 5.0 compliant, the device operates in the 2.4GHz frequency band, using GFSK modulation at 1Mbps data rate. The devices use a PCB meander-line antenna, and are powered by a primary Lithium / Manganese Dioxide (Li/MnO2) coin cell battery.

The device has two mutually exclusive operating modes: 1) Advertising Mode and 2) Connected Mode.

Advertising mode is utilized to broadcast connectable information to listening devices in a unidirectional fashion. To increase the chance of a listening device to connect to a Tile, the Tile broadcasts at an interval of 100ms, with a payload of 37 bytes – this allows a smartphone to easily recognize it.

Connected mode is used for bidirectional communication between the Tile and a smartphone. In Connected mode, the RF activity decreases. The interval at which the device and smart phone exchange data becomes 1.9 seconds primarily to save battery. The worst-case payload that the Tile sends to the smartphone is when the user uses the Tile to generate a notification in the smart phone by pressing the button. In this case, the payload is 37 bytes.

The worst-case interval between transmissions is 100 ms with a payload of 37 bytes in Advertising mode, so the following details will help establish the duty cycle in such mode of operation.

Antenna:

Type: Internal Antenna (Printed Circuit Board)
Frequency Range: 2400 – 2480 MHz

Modes During Normal Usage:

Tile's operate on two modes: Advertising and connected. During advertising, the device broadcasts BLE advertisement packets on three channels, 2402, 2426, and 2480 MHz. The device is said to be in 'connected mode' when it is connected to a Bluetooth master – most commonly a smartphone. During connected mode, data packets are exchanged between the handset and Tiles, every 1.9 seconds.

Advertising Mode Worst Case RF Duty Cycle Measurement Justification:

Tile exhibits its worst-case duty cycle factor during 'reverse ring'. In this case, the beaconing interval becomes 100 ms.

The ensuing figures 1 and 2, were taken with a spectrum analyzer in zero-span mode to capture RF power vs. time.

Figure 1, below, verifies the advertising RF burst duration of 310.4 µs.

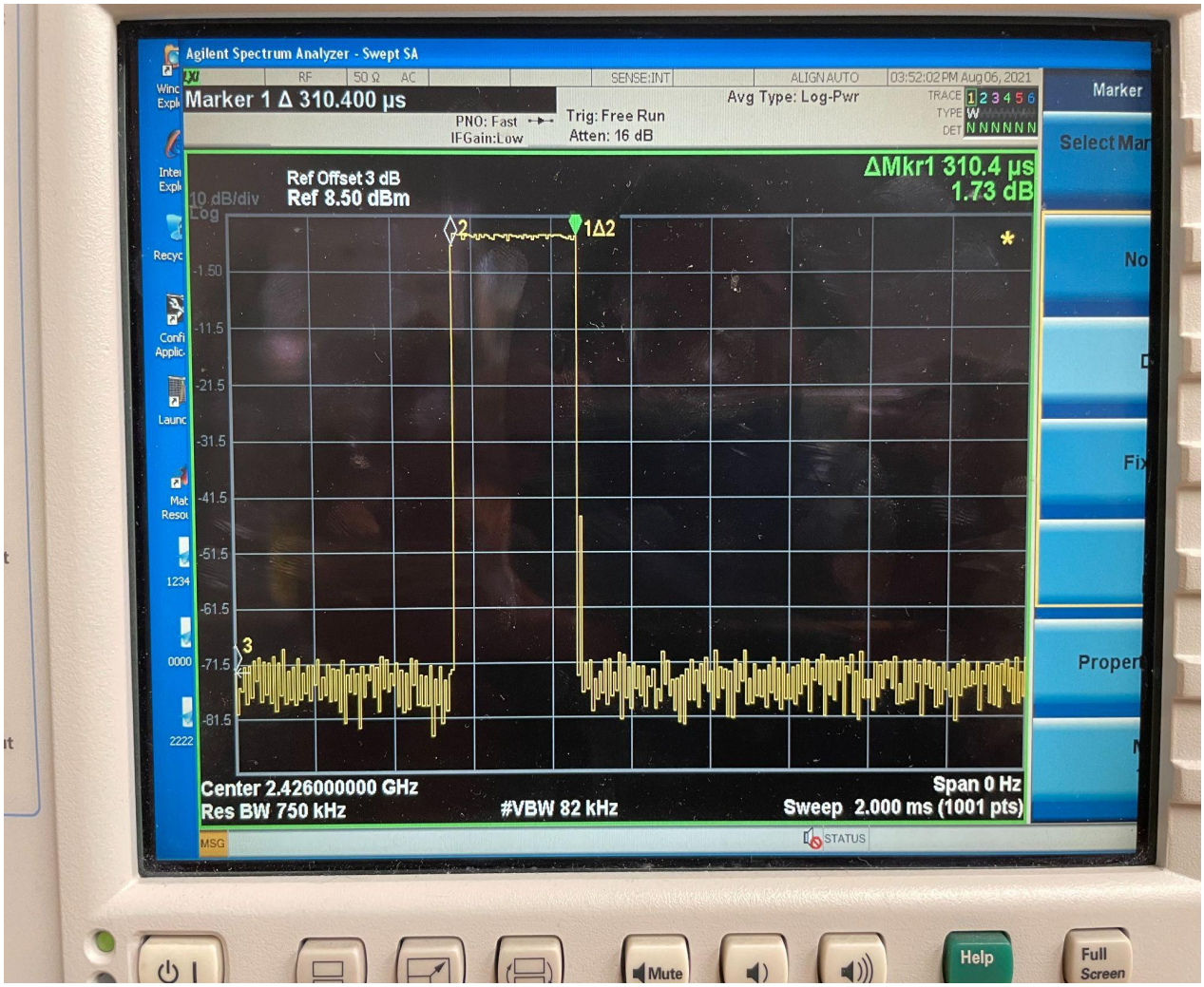


Figure 1. Measured $Adv.\ RF_{on}$ is 310.4 µs

Measured $Adv.\ RF_{on}$ is 310.4 µs and the beaconing interval during the reverse ring is 100ms. Its corresponding duty cycle factor is:

$$Measured\ Adv.\ Duty\ Cycle\ Factor\ = \frac{310.4\ \mu s \times 3}{100\ ms} \times 100\% \ = \ 0.931\%$$

Where $Adv.\ RF_{on}$ is multiplied by 3, since beaconing data is broadcasted in quick successions on 2402, 2426, and 2480 MHz during a single beacon event.

The max beacon interval is confirmed to be 100 ms in Figure 2, below:

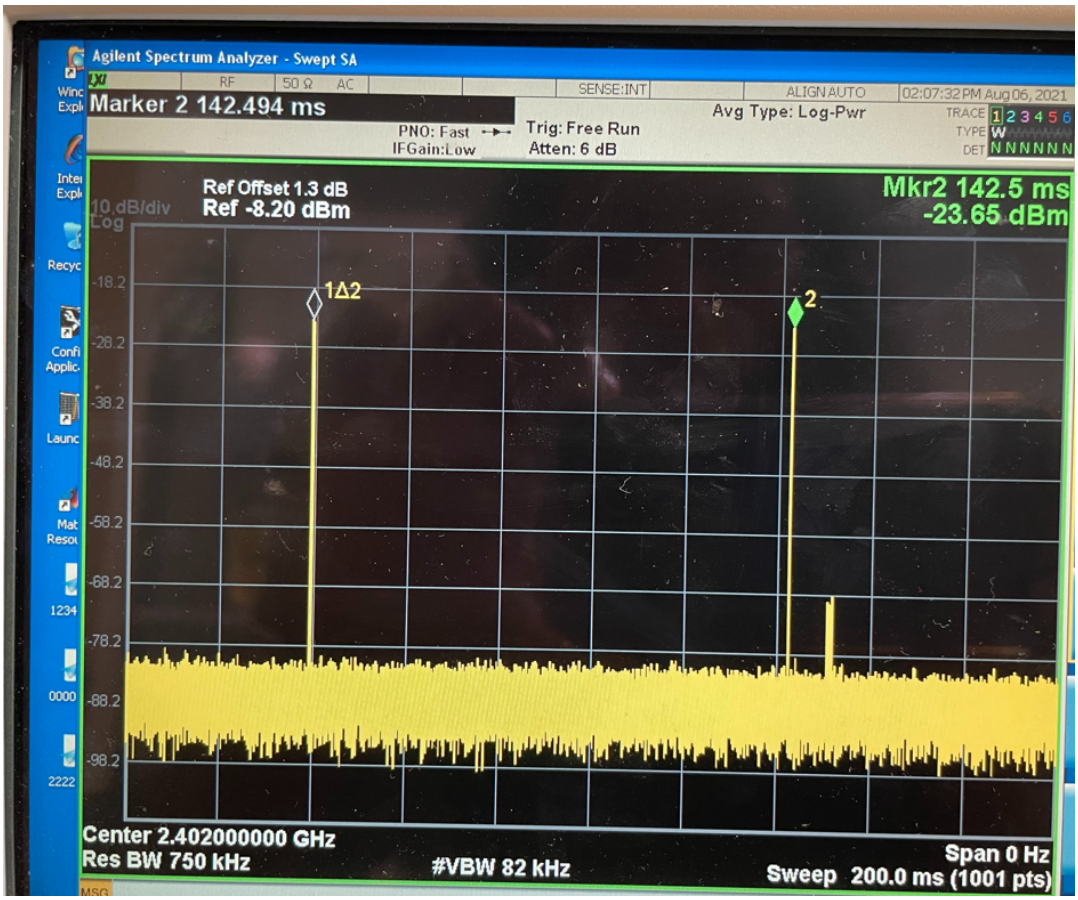


Figure 2. Advertising Events During 100 ms Sweep

Figure 2 demonstrates that 100 ms models the beacon interval sufficiently, since 2 advertisements were captured in a 200 ms sweep window.

Conclusion:

This data is being established to show the worst case duty cycle occurs when the device's reverse ring feature is triggered which occurs in advertising mode. This was found to be 0.931%. The advertising worst case duty cycle is much bigger than that of connected mode. This is due to the device transmitting simultaneously on 3 channels, using an iBeacon formatted payload, and shortening its beaconing interval to 100 ms.