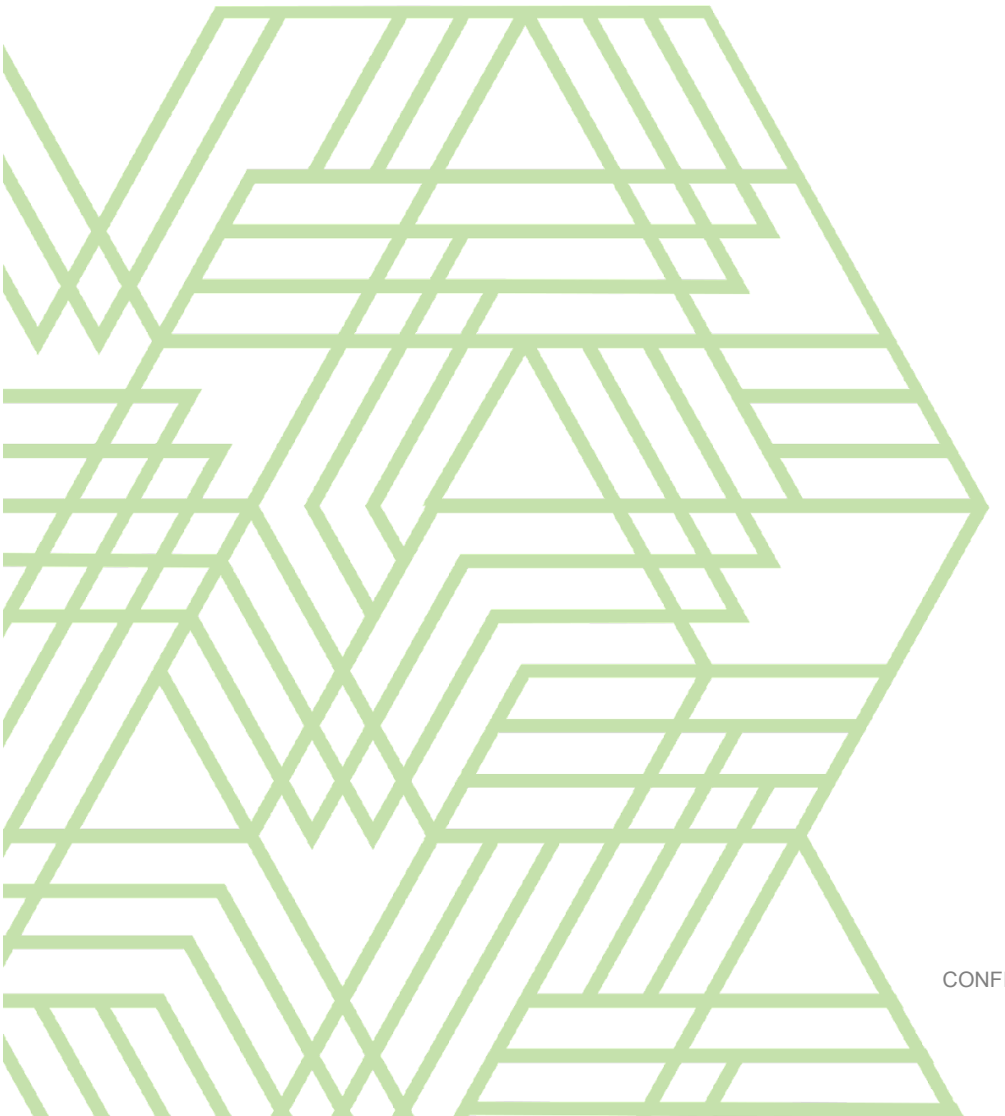
ATM3325 Tag Reference Design

Test Report

SUMMARY: This document provides radio performance, antenna performance, relevant certifications, power consumption, and application test results conducted on the ATM3325 Tag reference design.



Atmosic™

CONFIDENTIAL | Doc. No. ATM3325-TRTAG-0051

Table of Contents

List of Figures

List of Tables

Acronyms and Abbreviations

Acronyms	Definition
BQB	Bluetooth Certification Body
DUT	Device Under Test
EOC	Extreme Operating Conditions
EUT	Equipment Under Test
EVK	Evaluation Kit
HCI	Host Controller Interface
ISM	Industrial Scientific Medical
NOC	Normal Operating Conditions
RBW	Resolution Bandwidth
RF	Radio Frequency
RPB	Reference Design Programming Board
SDK	Software Development Kit
SoC	System-on-Chip
VBW	Video Bandwidth
VNA	Vector Network Analyzer

1. Purpose

This report presents the results of comprehensive testing conducted on the ATM3325 Tag reference design. Its purpose is to provide radio performance, antenna performance, relevant certifications, power consumption, and application test results. Please refer to subsequent sections for further details. Please note that this report reflects testing to date and subsequent changes may not be included.

2. Test Results

2.1 Radio Performance

2.1.1 Bluetooth LE Transmitter

The purpose of this test item is to verify Bluetooth LE transmit output power level, carrier drift, in-band emission, and modulation characteristics performance. The specifications of these test items need to meet Bluetooth SIG RF-PHY requirements.

Items	Conditions
VBAT	3.0 V
VDDIO	External VDDIO (connected to VBAT)
Temperature	25 °C
Test Equipment	TLF3000 Shielding Box
Cable Loss	1 dB
Packet length	255
SDK	Version 5.4.0.1
FW	HCI_Vendor

Table 1 - Bluetooth LE Transmitter Test Conditions

Bluetooth LE Transmitter Test Method

- Configure DUT with the Atmosic HCI_Vendor example, then follow below test procedure to connect DUT with one box tester TLF3000.
- All of the test results should meet BQB RF-PHY criteria.

Bluetooth LE Transmitter Test Setup

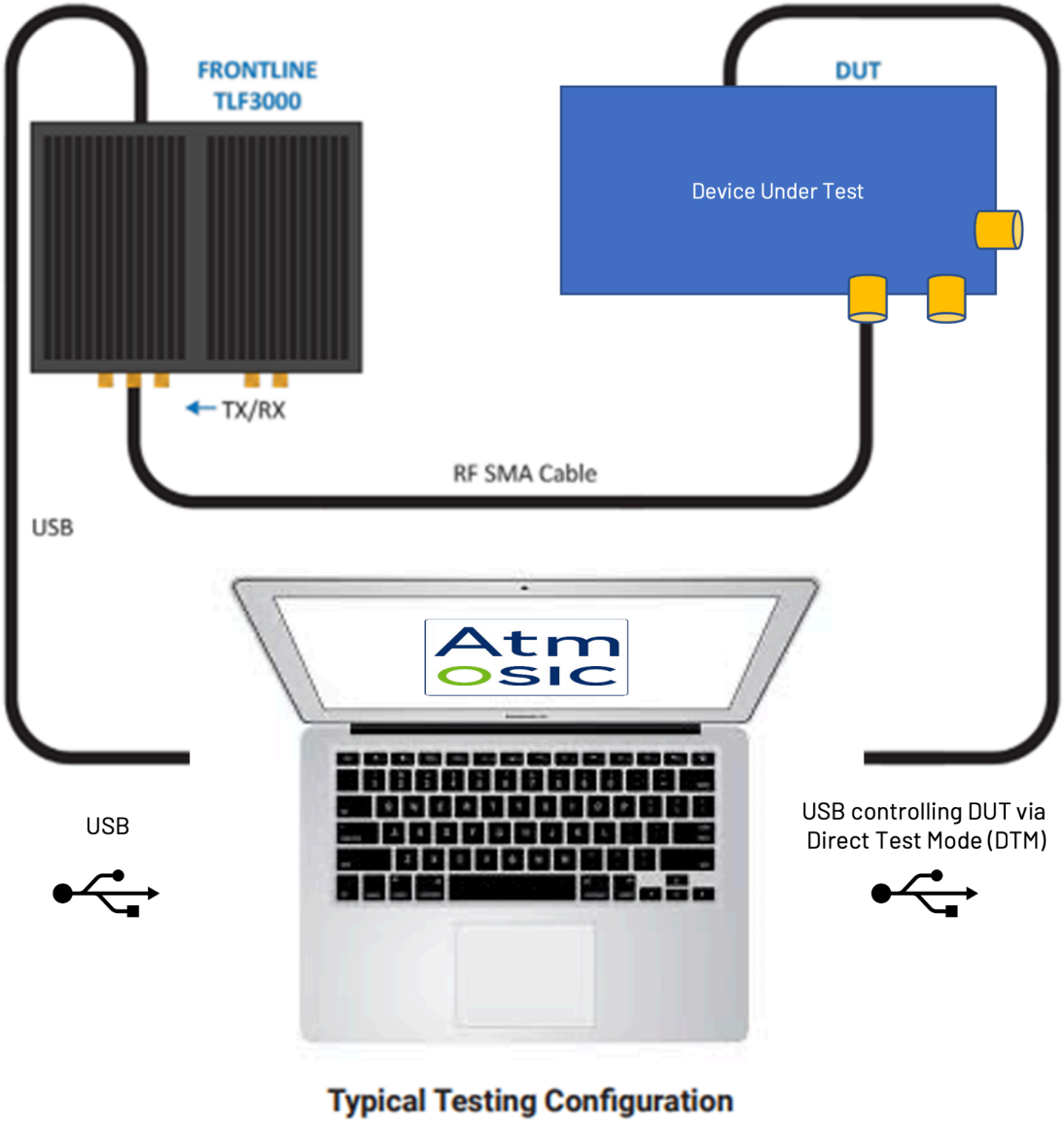


Figure 1 - Bluetooth LE Transmitter/Receiver Test Setup

Bluetooth LE Transmitter Test Result

Test Conditions						DUT 1			DUT 2			DUT 3		
Test items	Data Rate	Avg.			Unit	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Output Power	1M	0 dBm	+/-	1.5	dB	-0.1	0.2	0.6	-0.7	-0.5	-0.1	-0.4	-0.1	0.3
	1M	4 dBm	+/-	1.5	dB	4.2	4.5	5.0	3.5	3.8	4.4	3.8	4.2	4.7
	1M	8 dBm	+/-	1.5	dB	7.7	8.3	9.0	7.2	7.9	8.7	7.2	7.9	8.7
	1M	10 dBm	+/-	1.5	dB	10.0	10.4	10.8	9.5	10.0	10.6	9.5	10.0	10.6

Table 2 - Output Power

Test Conditions						DUT 1			DUT 2			DUT 3		
Test items	Data Rate	Test Criterion			Unit	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Carrier Drift (0 dBm)	1M	F0	< +/-	150	kHz	-11.64		1.6	-11.23		2.85	-17.38		-0.11
	1M	Fn	< +/-	150	kHz	-9.74		6.72	-7.63		6.27	-12.13		3.91
	1M	F0-Fn	< +/-	50	kHz	-16.57		9.21	-16.19		9.4	-21.17		10.41
	1M	F1-F0	< +/-	23	kHz	-5.52		12.02	-6.22		13.32	-1.95		15.21
	1M	Fn-Fn+5	< +/-	20	kHz	-13.32		12.59	-11.23		9.39	-12.6		13.59
	2M	F0	< +/-	150	kHz	-11.76		2.9	-8.69		4.6	-11		1.65
	2M	Fn	< +/-	150	kHz	-9.14		6.94	-7.83		5.51	-11.88		3.74
	2M	F0-Fn	< +/-	50	kHz	-16.57		9.47	-12.66		10.2	-12.98		12.41
	2M	F1-F0	< +/-	13.3	kHz	-3.64		10.66	-3.01		10.23	-4.24		10.47
	2M	Fn-Fn+5	< +/-	20	kHz	-11.45		14.1	-9.07		10.75	-13.73		13.74

Test Conditions						DUT 1			DUT 2			DUT 3		
Test items	Data Rate	Test Criterion			Unit	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Carrier Drift (4 dBm)	1M	F0	< +/-	150	kHz	-10.61		-4.69	-10.09		-3.43	-13.12		-8.1
	1M	Fn	< +/-	150	kHz	-5.03		2.51	-5.91		4.12	-8.06		-0.26
	1M	F0-Fn	< +/-	50	kHz	-11.98		-0.58	-12.87		-0.07	-12.44		-1.38
	1M	F1-F0	< +/-	23	kHz	4.69		10.81	2.49		10.73	3.65		10.6
	1M	Fn-Fn+5	< +/-	20	kHz	-5.15		4.35	-7.42		6.31	-5.29		5.32
	2M	F0	< +/-	150	kHz	-6.85		-1.6	-6.44		-1.2	-9.39		-5.48
	2M	Fn	< +/-	150	kHz	-5.35		2.87	-5.08		3.92	-8.19		0.07
	2M	F0-Fn	< +/-	50	kHz	-8.34		2.09	-8.66		2.17	-8.73		1.39
	2M	F1-F0	< +/-	13.3	kHz	1.38		8.34	1.16		8.47	2.53		8.55
	2M	Fn-Fn+5	< +/-	20	kHz	-5.55		5.92	-7.2		5.86	-5.34		6.24
Carrier Drift (8 dBm)	1M	F0	< +/-	150	kHz	-14.99		-3.74	-12.77		1.15	-18.47		-6.05
	1M	Fn	< +/-	150	kHz	-7.16		4.8	-7.37		4.68	-10.64		2.11
	1M	F0-Fn	< +/-	50	kHz	-17.28		2.09	-17.19		6.38	-19.07		3.11
	1M	F1-F0	< +/-	23	kHz	3.73		15.65	-4.59		15.64	3.02		16.32
	1M	Fn-Fn+5	< +/-	20	kHz	-9.5		8.82	-7.58		7.09	-11.3		10.22
	2M	F0	< +/-	150	kHz	-7.21		1.61	-7.84		3.06	-9.72		0.61
	2M	Fn	< +/-	150	kHz	-7.8		4.84	-7		5.04	-9.72		2.28
	2M	F0-Fn	< +/-	50	kHz	-10.29		7.87	-10.12		8.78	-9.8		8.78
	2M	F1-F0	< +/-	13.3	kHz	-1.34		8.12	-2.47		9.17	-4.51		8.25

Test Conditions						DUT 1			DUT 2			DUT 3		
Test items	Data Rate	Test Criterion			Unit	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
	2M	Fn-Fn+5	< +/-	20	kHz	-8.88		10.18	-8.76		7.98	-10.68		10.35
Carrier Drift (10 dBm)	1M	F0	< +/-	150	kHz	-11.64		1.6	-11.23		2.85	-17.38		-0.11
	1M	Fn	< +/-	150	kHz	-9.74		6.72	-7.63		6.27	-12.13		3.91
	1M	F0-Fn	< +/-	50	kHz	-16.57		9.21	-16.19		9.4	-21.17		10.41
	1M	F1-F0	< +/-	23	kHz	-5.52		12.02	-6.22		13.32	-1.95		15.21
	1M	Fn-Fn+5	< +/-	20	kHz	-13.32		12.59	-11.23		9.39	-12.6		13.59
	2M	F0	< +/-	150	kHz	-11.76		2.9	-8.69		4.6	-11		1.65
	2M	Fn	< +/-	150	kHz	-9.14		6.94	-7.83		5.51	-11.88		3.74
	2M	F0-Fn	< +/-	50	kHz	-16.57		9.47	-12.66		10.2	-12.98		12.41
	2M	F1-F0	< +/-	13.3	kHz	-3.64		10.66	-3.01		10.23	-4.24		10.47
	2M	Fn-Fn+5	< +/-	20	kHz	-11.45		14.1	-9.07		10.75	-13.73		13.74

Table 3 - Carrier Drift

Test Conditions						DUT 1			DUT 2			DUT 3		
Test items	Data Rate	Test Criterion			Unit	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Modulation Index (0 dBm)	1M	Min. deltaF1	>	225	kHz	238.57			242.27			241.35		
	1M	Max. deltaF1	<	275	kHz			244.25			246.77			244.11
	1M	F2/F1	>	0.8		1.055		1.118	0.976		1.038	1.015		1.075

Test Conditions						DUT 1			DUT 2			DUT 3		
Test items	Data Rate	Test Criterion			Unit	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
	1M	deltaF2	>	99.9	%	99.7		100.0	99.9		100.0	99.8		100.0
	2M	Min. deltaF1	>	450	kHz	508.95			500.54			517.13		
	2M	Max. deltaF1	<	550	kHz			513.97			513.68			526.25
	2M	F2/F1	>	0.8		0.96		0.995	0.947		0.978	0.943		0.971
	2M	deltaF2	>	99.9	%	100.0		100.0	100.0		100.0	100.0		100.0
Modulation Index (4 dBm)	1M	Min. deltaF1	>	225	kHz	239.13			242.54			241.74		
	1M	Max. deltaF1	<	275	kHz			241.94			247.27			244.1
	1M	F2/F1	>	0.8		1.055		1.104	0.976		1.032	1.015		1.062
	1M	deltaF2	>	99.9	%	100.0		100.0	100.0		100.0	100.0		100.0
	2M	Min. deltaF1	>	450	kHz	509.1			500.59			517.77		
	2M	Max. deltaF1	<	550	kHz			513.97			511.59			525.17
	2M	F2/F1	>	0.8		0.983		0.996	0.952		0.979	0.959		0.97
	2M	deltaF2	>	99.9	%	100.0		100.0	100.0		100.0	100.0		100.0
Modulation Index (8 dBm)	1M	Min. deltaF1	>	225	kHz	239.05			242.29			241.75		
	1M	Max. deltaF1	<	275	kHz			242.14			246.33			244.25
	1M	F2/F1	>	0.8		1.053		1.105	0.974		1.034	1.016		1.067
	1M	deltaF2	>	99.9	%	100.0		100.0	100.0		100.0	100.0		100.0
	2M	Min. deltaF1	>	450	kHz	509.46			501.07			517.4		
	2M	Max. deltaF1	<	550	kHz			513.28			511.96			525.18

Test Conditions						DUT 1			DUT 2			DUT 3		
Test items	Data Rate	Test Criterion			Unit	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
	2M	F2/F1	>	0.8		0.98		0.992	0.951		0.977	0.956		0.966
	2M	deltaF2	>	99.9	%	100.0		100.0	100.0		100.0	100.0		100.0
Modulation Index (10 dBm)	1M	Min. deltaF1	>	225	kHz	238.57			242.27			241.35		
	1M	Max. deltaF1	<	275	kHz			244.25			246.77			244.11
	1M	F2/F1	>	0.8		1.061		1.118	0.976		1.038	1.017		1.075
	1M	deltaF2	>	99.9	%	99.7		100.0	99.9		100.0	99.8		100.0
	2M	Min. deltaF1	>	450	kHz	509.35			501			517.13		
	2M	Max. deltaF1	<	550	kHz			513.97			513.68			526.25
	2M	F2/F1	>	0.8		0.96		0.969	0.947		0.967	0.943		0.952
	2M	deltaF2	>	99.9	%	100.0		100.0	100.0		100.0	100.0		100.0

Table 4 - Modulation Index

Test Conditions						DUT 1			DUT 2			DUT 3		
Test items	Data Rate	Test Criterion			Unit	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Inband Emission (0 dBm)	1M	max Pwr @ +/-2 MHz	<	-20	dBm			-27.95			-29.43			-28.78
	1M	max Pwr @ >= +/-3 MHz	<	-30	dBm			-33.65			-34.38			-34.3
	2M	max Pwr @ +/-2 MHz	<	-20	dBm			-37.03			-37.53			-37.03
	2M	max Pwr @ >= +/-3 MHz	<	-30	dBm			-40.52			-40.92			-41.3

Test Conditions						DUT 1			DUT 2			DUT 3		
Test items	Data Rate	Test Criterion			Unit	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Inband Emission (4 dBm)	1M	max Pwr @ +/-2 MHz	<	-20	dBm			-37.06			-37.57			-37.32
	1M	max Pwr @ >= +/-3 MHz	<	-30	dBm			-40.97			-41.5			-41.18
	2M	max Pwr @ +/-2 MHz	<	-20	dBm			-43.47			-43.98			-43.47
	2M	max Pwr @ >= +/-3 MHz	<	-30	dBm			-46.48			-47.25			-47.11
Inband Emission (8 dBm)	1M	max Pwr @ +/-2 MHz	<	-20	dBm			-31.84			-32.67			-32.03
	1M	max Pwr @ >= +/-3 MHz	<	-30	dBm			-35.91			-36.53			-36.39
	2M	max Pwr @ +/-2MHz	<	-20	dBm			-39.1			-39.38			-39.1
	2M	max Pwr @ >= +/-3 MHz	<	-30	dBm			-42.62			-42.86			-43.51
Inband Emission (10 dBm)	1M	max Pwr @ +/- 2MHz	<	-20	dBm			-37.06			-37.57			-37.32
	1M	max Pwr @ >= +/-3 MHz	<	-30	dBm			-40.97			-41.5			-41.18
	2M	max Pwr @ +/-2 MHz	<	-20	dBm			-43.47			-43.98			-43.47
	2M	max Pwr @ >= +/- 3MHz	<	-30	dBm			-46.48			-47.25			-47.11

Table 5 - Inband Emission

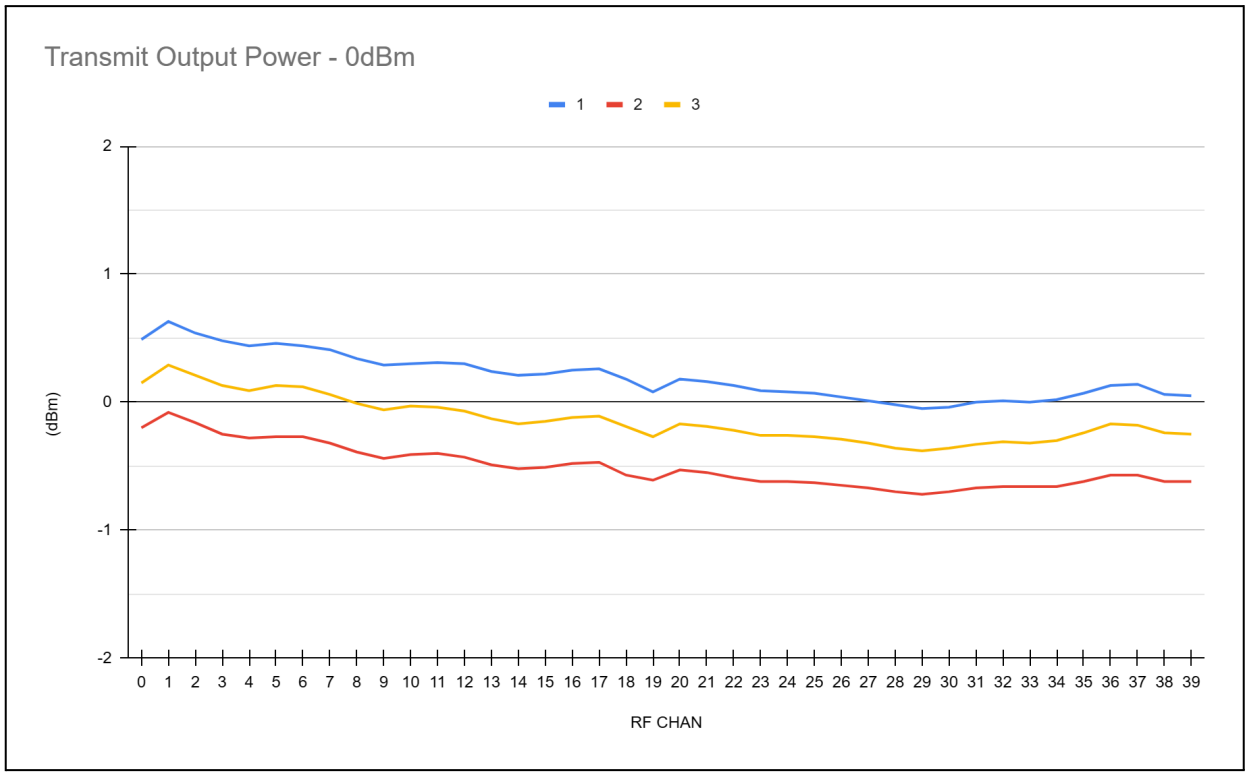


Figure 2 - Transmit Output Power of Each Channel at 0 dBm

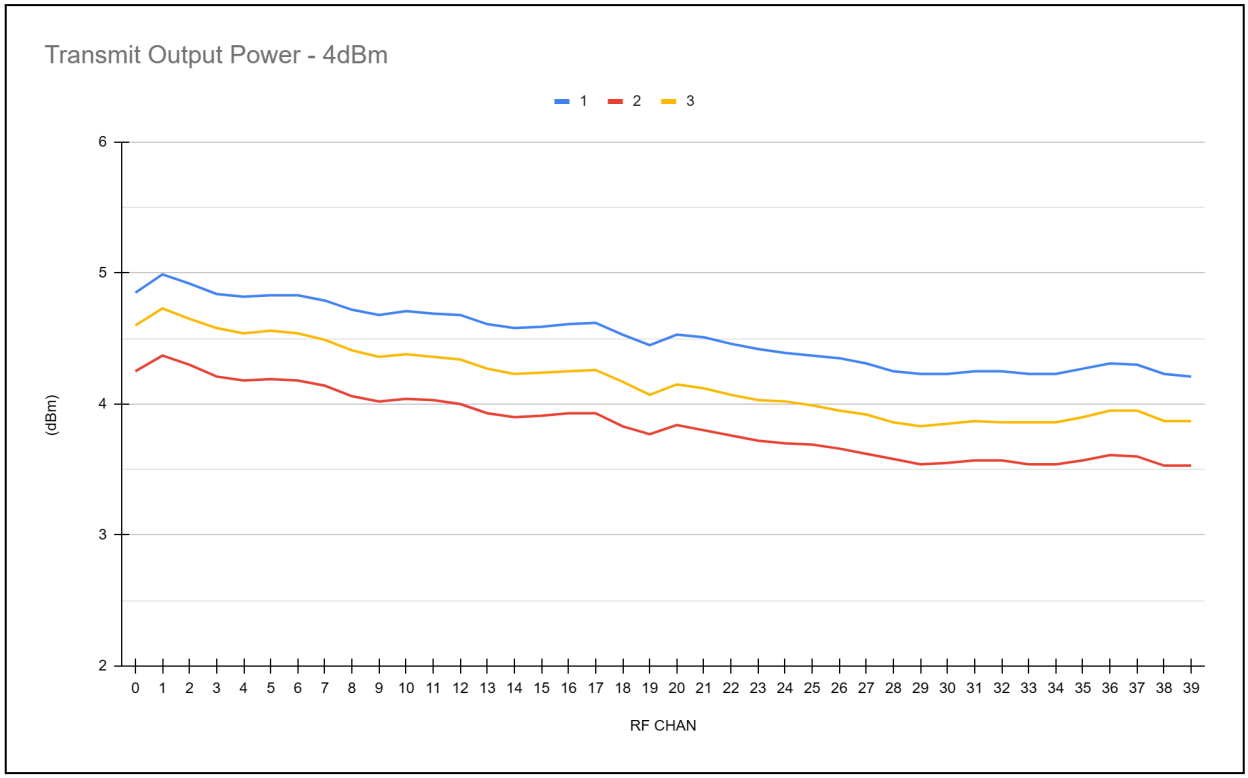


Figure 3 - Transmit Output Power of Each Channel at 4 dBm

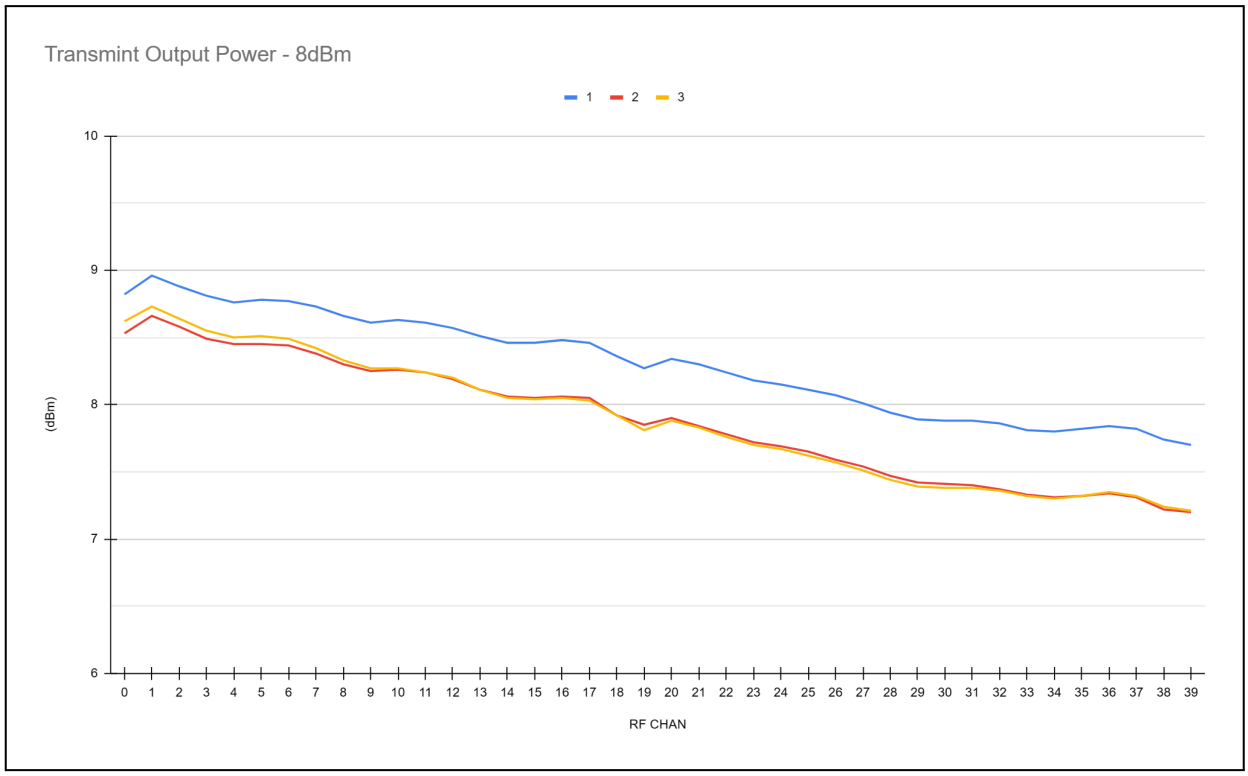


Figure 4 - Transmit Output Power of Each Channel at 8 dBm

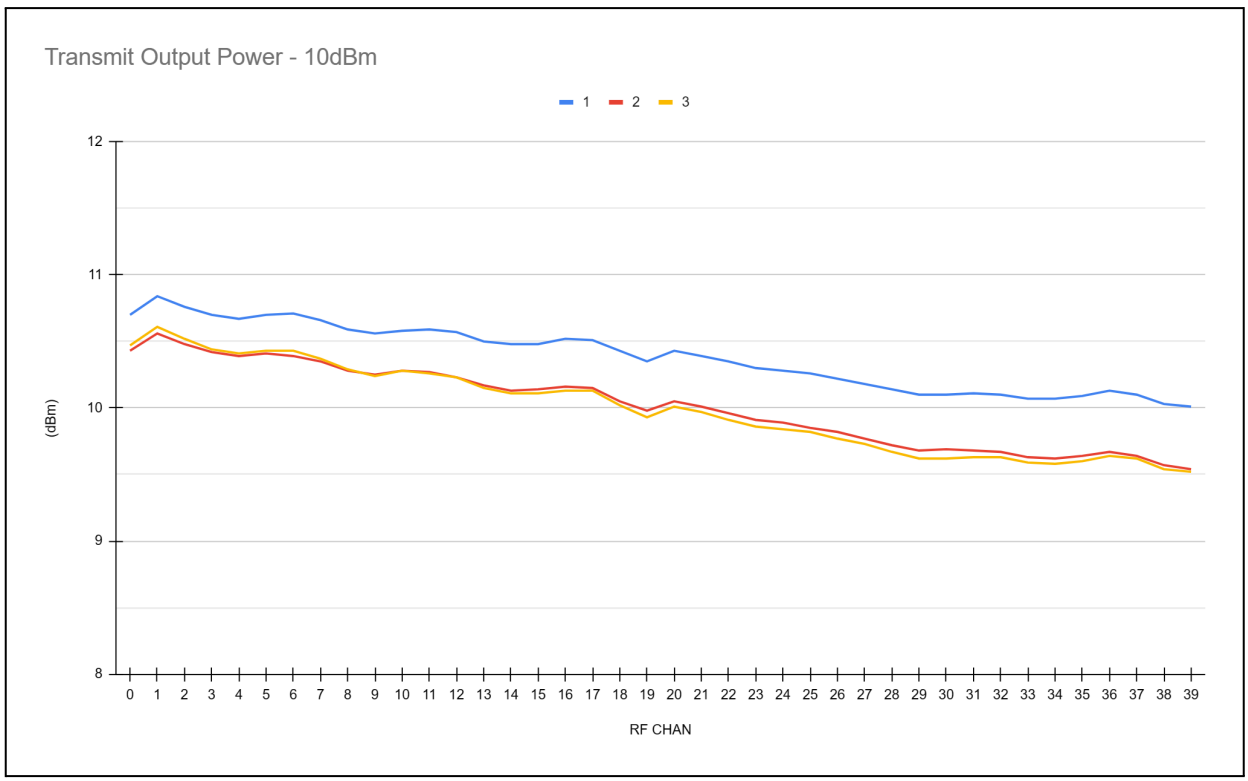


Figure 5 - Transmit Output Power of Each Channel at 10 dBm

2.1.2 Bluetooth LE Receiver

This test item verifies that the receiver sensitivity is within limits at normal operating conditions when receiving a 1 Mbps and 2 Mbps signal, respectively.

Items	Conditions
VBAT	3.0 V
VDDIO	External VDDIO (connected to VBAT)
Temperature	25 °C
Test Equipment	TLF3000 Shielding Box
Cable Loss	1 dB
Packet length	37
Dirty Transmitter	Dirty Off
SDK	Version 5.4.0.1
FW	HCI_Vendor

Table 6 - Bluetooth LE Receiver Test Conditions

Bluetooth LE Receiver Test Method

- Configure DUT with the Atmosic HCI_Vendor example, then follow the below test procedure to connect DUT with one box tester TLF3000.
- All of the test results should meet BQB RF-PHY Criteria.

Bluetooth LE Receiver Test Setup

- See Figure 1.

Bluetooth LE Receiver Test Result

Test Conditions						DUT 1			DUT 2			DUT 3		
Test items	Data Rate	Test Criterion			Unit	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
RX Sensitivity	1M	Avg.	<	-94	dBm	-95.5	-94.9	-93.5	-96	-95.3	-95	-96	-95.4	-95
	2M	Avg.	<	-92	dBm	-93.5	-92.9	-92	-93.5	-93.3	-93	-93.5	-93.3	-93

Table 7 - Bluetooth LE Receiver Test Result

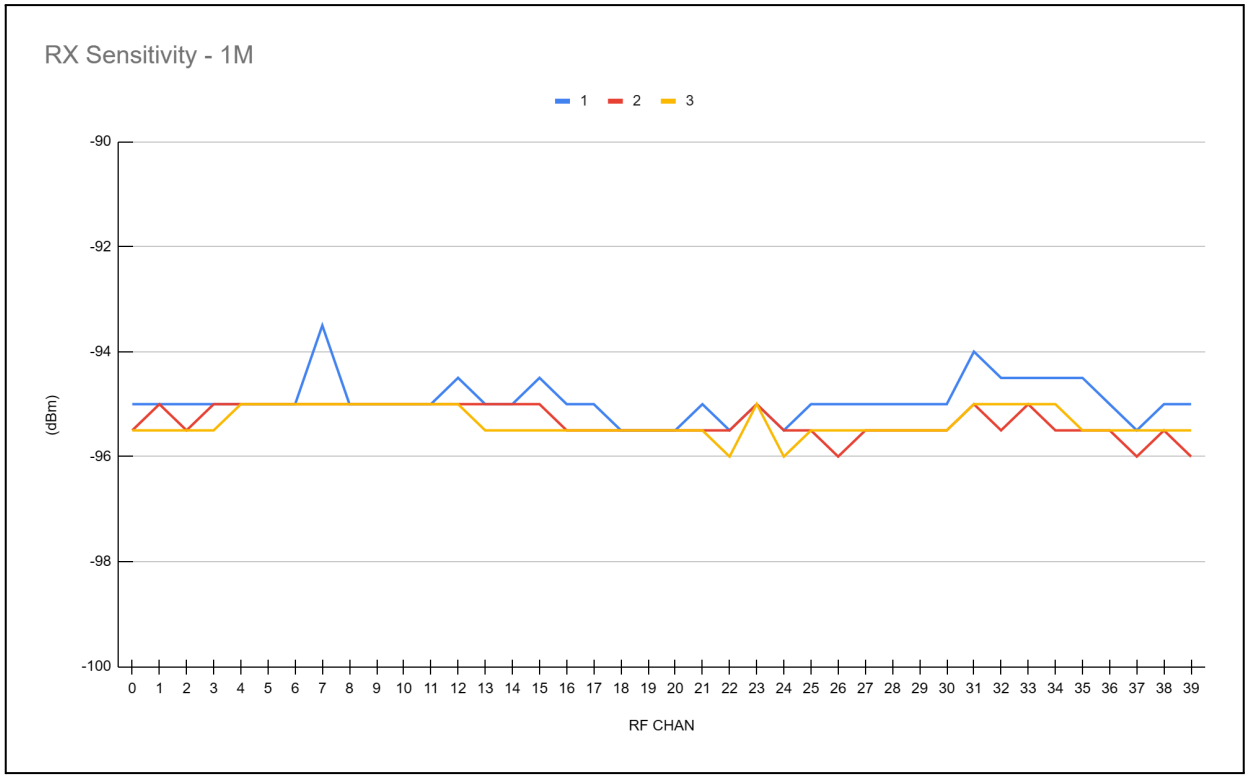


Figure 6 - RX Sensitivity - 1M

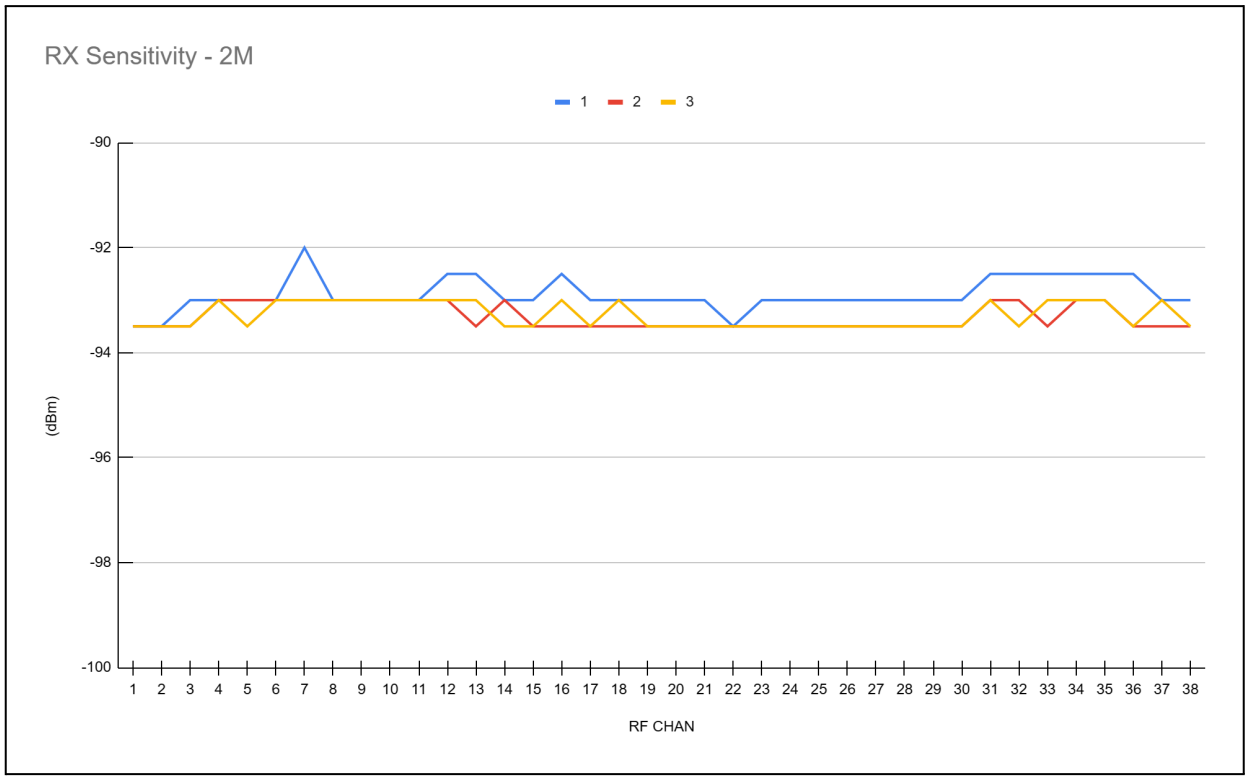


Figure 7 - RX Sensitivity - 2M

2.2 Antenna Performance

The purpose of tuning and verification of the Bluetooth LE antenna is to make sure the antenna operating frequency range can meet ISM band requirements and S11 under -10 dB at least to make sure 90% energy can be delivered to space.

Items	Conditions
Temperature	25 °C
Test Equipment	Keysight Handheld Microwave Analyzer N9917A

Table 8 - Antenna Performance Test Conditions

2.2.1 Antenna Performance Test Method

- Measure the Antenna S11 by VNA with enclosure and make sure it can be operated in the ISM band.
- If the initial antenna frequency range is out of the ISM band, the PI-type or Y-type matching circuit is needed to adjust the frequency back to the ISM band.

- The antenna S11 value should be smaller than -10 dB, which means 90% of the RF signal could be radiated into space and only 10% of the energy will be reflected back to the DUT.

2.2.2 Antenna Performance Test Setup

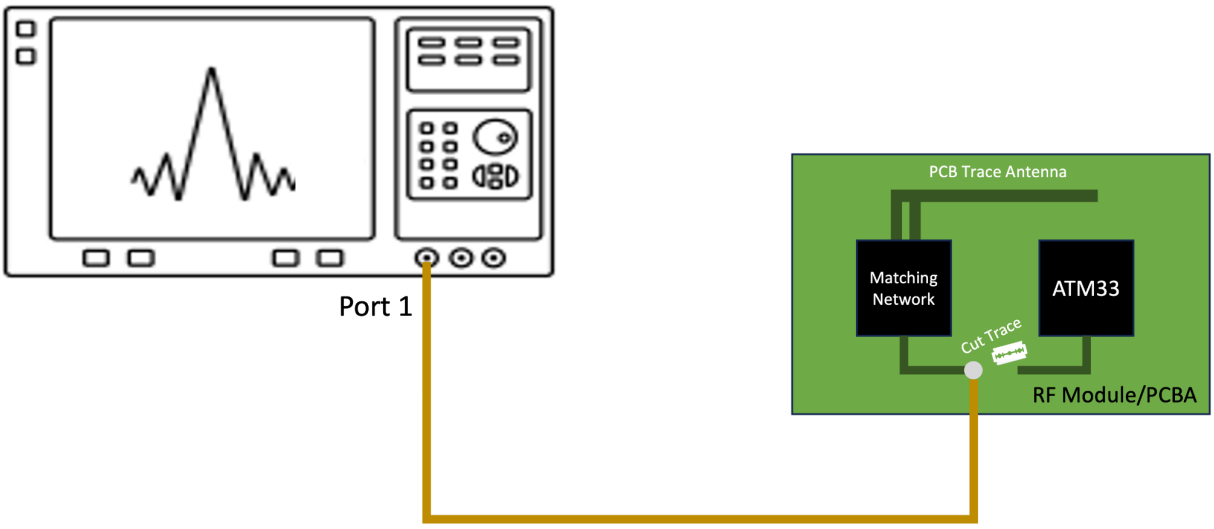


Figure 8 - Test Setup of Antenna Performance

2.2.3 Antenna Performance Test Result

Frequency (MHz)	Antenna S11 (dB)	Criteria(dB)
2402	-10.10	<-10
2450	-16.76	<-10
2480	-22.09	<-10

Table 9 - Antenna S11 Test Result

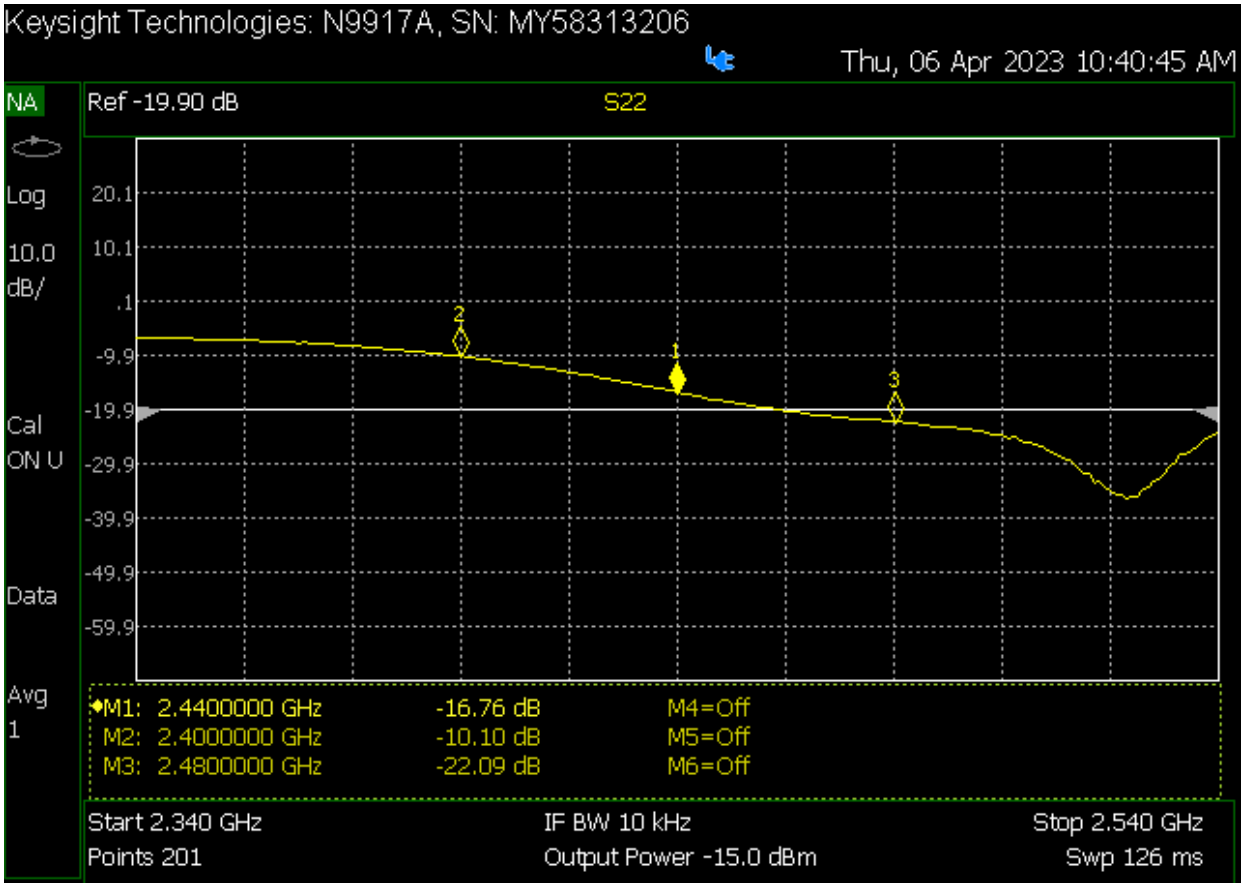


Figure 9 - Antenna S11 Test Result

2.3 Regulatory Testing

2.3.1 Conducted Harmonic

Conducted harmonic testing to check the unwanted noise level out from the RF path according to FCC criteria. The results can be used as a pre-test validation before official testing in the certification lab.

The following table is the condition of DUT for reference.

Items	Conditions
VBAT	3.0 V
VDDIO	External VDDIO (connected to VBAT)
Temperature	25 °C
Equipment	Spectrum Analyzer
Cable Loss	1 dB

Items	Conditions
Packet length	255
SDK	Version 5.4.0.1
FW	HCI_Vendor

Table 10 - Test Conditions of Regulatory Testing

Conducted Harmonic Test Method

DUT connected to the laptop through Atmosic RPB with UART0 interface. The RF output of DUT was connected to the spectrum analyzer by the RF cable. The setting of the spectrum is shown in the Test Setup section.

The Atmosic RF Tool is used to control transmission continually with `Enable Infinite`=1. TX Power and link rate can be changed in the RF tool according to test requirements.

The level of the main tone needs to be confirmed before recording the harmonic level.

Conducted Harmonic Test Setup

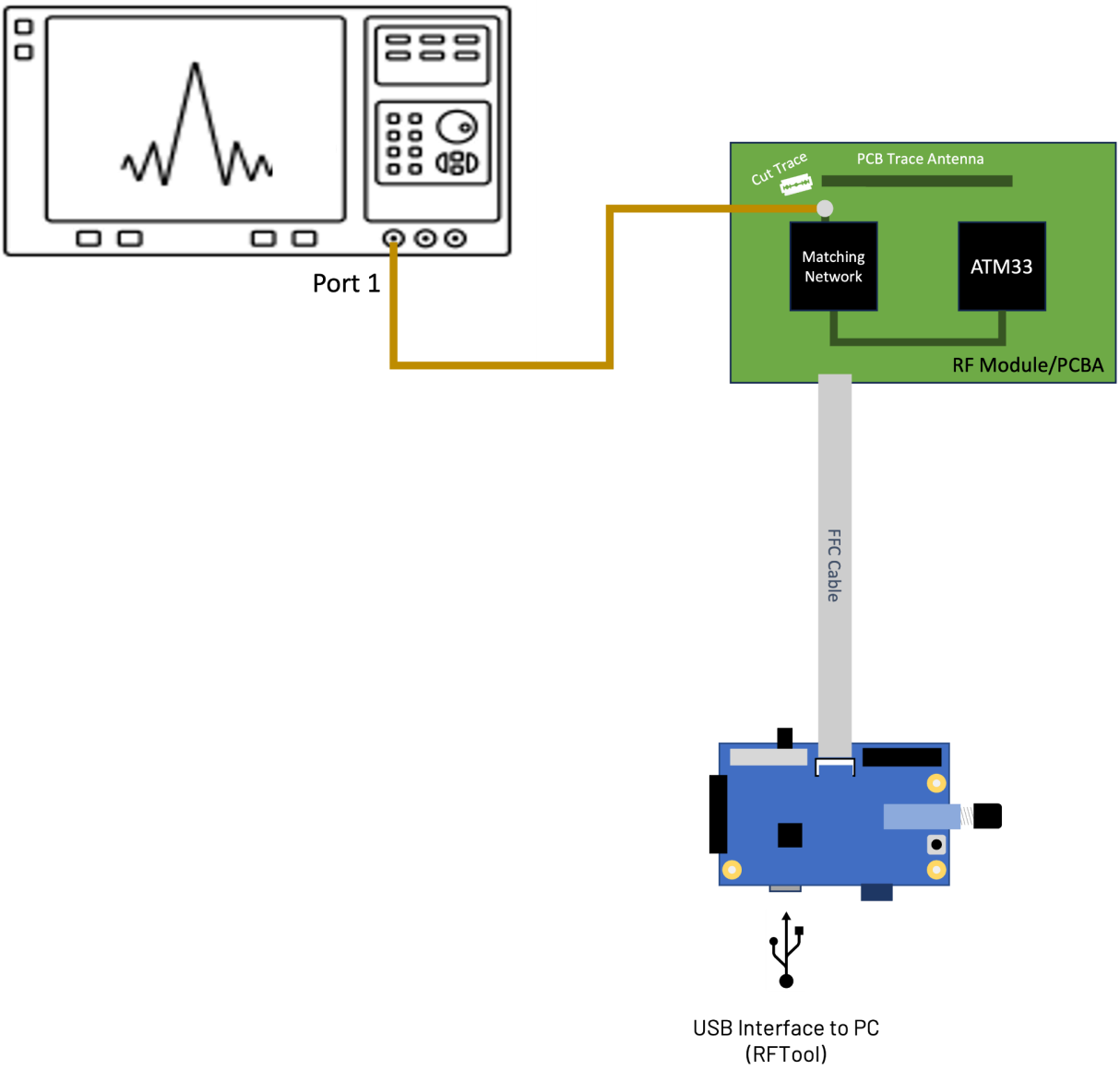


Figure 10 - Conducted Harmonic Test Setup

- Spectrum setting when checking the harmonic.

Items	Setting
RBW/VBW	RBW=1 MHz, VBW=3 MHz
Detector	RMS average
Trace mode	average (100 times)
Reference level	6 ~ 10 dB higher than the target TX Power

Table 11 - Spectrum Setting When Harmonic Checking

- Spectrum setting when checking the main tone.

Items	Setting
RBW/VBW	RBW=1 MHz, VBW=3 MHz
Detector	Positive Peak
Trace mode	Max hold
Reference level	10dB higher than the target TX Power

Table 12 - Spectrum Setting When Main Tone Checking

- Frequency range setting of the spectrum during testing.

Items	Frequency Range(GHz)
2nd Harmonic	4.5 GHz ~ 5 GHz
3rd Harmonic	7 GHz ~ 7.5 GHz
5th Harmonic	12 GHz ~ 12.5 GHz

Table 13 - Frequency Range Setting of Spectrum During Testing

Conducted Harmonic Test Criteria

The unwanted noise level should be lower than -41 dBm.

Conducted Harmonic Test Result

DUT	TX Power Setting	VCC	Link Rate	Channel	Main Tone Level (dBm)	2nd Harmonic (dBm)	3rd Harmonic (dBm)	5th Harmonic (dBm)	Test Result (Pass/Fail)
1	8	3	1M	0	8.58	-47.39	-54.99	-55.54	Pass
			1M	19	8.605	-46.225	-55.535	-54.415	Pass
			1M	39	8.559	-44.201	-56.151	-53.301	Pass
	0	3	1M	0	0.611	-57.79	-56.98	-53.76	Pass
			1M	19	0.977	-55.99	-56.74	-52.84	Pass
			1M	39	1.017	-53.45	-56.62	-54.04	Pass

Table 14 - Conducted Harmonic Test Result

2.3.2 FCC Pre-test (Radiated Harmonic)

Test in certification lab to confirm harmonic pass FCC regulatory rule.

The following table is the condition of EUT for reference.

Items	Conditions
VBAT	3.0 V
VDDIO	External VDDIO (connected to VBAT)
Temperature	25 °C
Equipment	Spectrum Analyzer
Cable Loss	1 dB
SDK	Version 5.4.0.1
FW	HCI_Vendor

Table 15 - FCC Pre-test (Radiated Harmonic) Test Conditions

FCC Pre-test Test Method

The RF output of EUT was connected to the spectrum analyzer by an RF cable. The path loss was compensated by the results for each measurement. Spectrum analyzer settings should follow FCC rules (details can be checked with the certification lab). Allow the trace to stabilize, and use the peak and delta measurements to record the result.

FCC Pre-test Test Setup

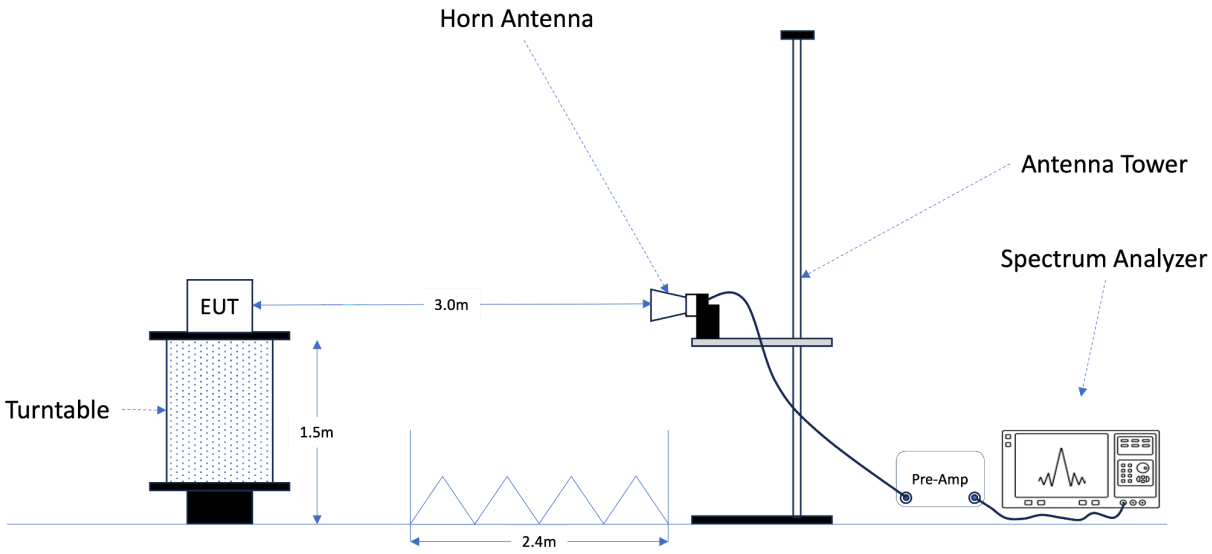


Figure 11 - FCC Pre-test (Radiated Harmonic) Test Setup

FCC Pre-test Test Result

DUT	HW Version	FW	TX Power (dBm)	Link Rate	Channel	Margin at 2nd Harmonic (AV) (dB)	Margin at 3rd Harmonic (AV) (dB)	Margin at 5th Harmonic (AV) (dB)
1	V1	SDK 5.4.0.1 (HCI_Vendor)	8	1M	0	-8.46	NA	-9.9
				1M	19	-11.38	-11.9	-10.04
				1M	39	-9.54	-12.89	-7.24

Table 16 - FCC Pre-test (Radiated Harmonic) Test Result

2.3.3 Conducted Band Edge

Confirm band edge status before the official test in the certification lab.

The following table is the condition of DUT for reference.

Items	Conditions
VBAT	3.0 V
VDDIO	External VDDIO (connected to VBAT)
Temperature	25 °C
Equipment	Spectrum Analyzer
Cable Loss	1 dB
SDK	Version 5.4.0.1
FW	HCI_Vendor

Table 17 - Conducted Band Edge Test Conditions

Conducted Band Edge Test Method

DUT connected to the laptop through the Atmosic RPB with UART0 interface. The RF output of DUT was connected to the spectrum analyzer by the RF cable. The setting of the spectrum is in the Test Setup section.

The Atmosic RF Test Tool is used to control transmission continually with “Enable Infinite”=1. TX Power and link rate can be changed in the RF Test tool according to test requirements.

The level of the main tone needs to be confirmed before recording the harmonic level. See Figure 10 for the test setup.

Conducted Band Edge Test Setup

- Spectrum setting when frequency lower than 2390 MHz and higher than 2483.5 MHz.

Items	Setting
RBW/VBW	RBW=1 MHz, VBW=3 MHz
Detector	RMS average
Trace mode	average (100 times)
Reference level	6 ~ 10 dB higher than the target TX Power

Table 18 - Spectrum Setting when Frequency Lower than 2390 MHz and Higher than 2483.5 MHz

- Spectrum setting when frequency between 2390 MHz and 2400 MHz.

Items	Setting
RBW/VBW	RBW=100 kHz, VBW=300 kHz
Detector	Positive Peak
Trace mode	Max Hold
Reference level	10 dB higher than the target TX Power

Table 19 - Spectrum Setting when Frequency between 2390 MHz and 2400 MHz

- Spectrum setting when checking the main tone.

Items	Setting
RBW/VBW	RBW=1 MHz, VBW=3 MHz
Detector	Positive Peak
Trace mode	Max hold
Reference level	10 dB higher than the target TX Power

Table 20 - Spectrum Setting when Main Tone Checking

Conducted Band Edge Test Criteria

Two criteria need to be considered and passed:

- Band edge emission.
    - In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the unwanted noise level should be at least 20 dB below the peak value of the main carrier signal in the 100 kHz bandwidth within the band. (Blue section of Figure 12) In this case, the RBW/VBW setting of the spectrum should be the same as in Table 19.
    - Since the unwanted noise may also be in the restricted band when the frequency range is lower than 2390 MHz and higher than 2483.5 MHz, production needs to pass both “Band-Edge” and “Emission in Restricted Band”. In this case, bottle-neck will be the criteria of “Emission in Restricted Band” in typical cases. (Red section of Figure 12) In this case, the RBW/VBW setting of the spectrum should be the same as in Table 18.
    - Final criteria to combine both above parts which can be found in Figure 12. When the frequency is between 2390 MHz and 2400 MHz, the blue line is used as the criteria, otherwise, the red line should be used as the criteria.

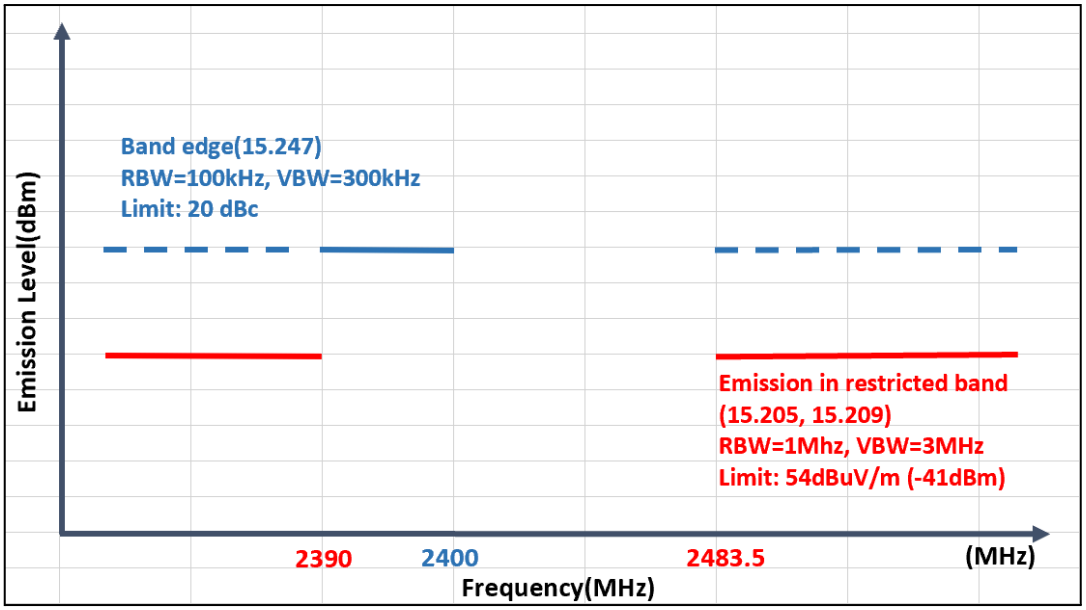


Figure 12 - Test Criteria of Band Edge Emission and Emission in Restricted Range

Conducted Band Edge Test Result

DUT	TX Power Setting	Link Rate	Channel	Main Tone Level (dBm)	Peak value lower 2390 MHz (dBm)	Peak value between 2390 ~2400 MHz (dBm)	Peak value higher 2483.5 MHz (dBm)	Test Result (Pass/Fail)
1	10	1M	0	10.09	-57.59	-43.64	NA	Pass
		1M	39	11	NA	NA	-47.16	Pass
		2M	1	9.964	-53.34	-43.73	NA	Pass
		2M	38	10.66	NA	NA	-47.42	Pass
	8	1M	0	8.383	-56.78	-44.9	NA	Pass
		1M	39	9.137	NA	NA	-48.1	Pass
		2M	1	8.433	-55.74	-46.06	NA	Pass
		2M	38	8.893	NA	NA	-48.62	Pass
	4	1M	0	4.442	--57.75	-49.91	NA	Pass
		1M	39	5.186	NA	NA	-52.14	Pass
		2M	1	4.392	-55.69	-48.5	NA	Pass
		2M	38	4.979	NA	NA	-52.28	Pass
	0	1M	0	0.686	-58.19	-52.96	NA	Pass
		1M	39	1.165	NA	NA	-54.91	Pass
		2M	1	0.613	-57.79	-52.47	NA	Pass
		2M	38	0.923	NA	NA	-55.43	Pass

Table 21 - Conducted Band Edge and Emission Test Result

2.3.4 Pre-BQB Test

Run testing conducted in the lab according to some items of BQB to have confidence for BQB in the certification lab.

Table 22 shows the condition of DUT for reference.

Items	Conditions
VBAT	3.0 V
VDDIO	External VDDIO (connected to VBAT)
Temperature	25 °C
Equipment	Spectrum Analyzer

Cable Loss	1 dB
SDK	Version 5.4.0.1
FW	HCI_Vendor

Table 22 - Pre-BQB Test Conditions

Pre-BQB Test Method

- DUT connected to Bluetooth LE one box tester (TLF3000) by RF cable. Atmosic RPB will be the bridge between the laptop and DUT.
- Pre-BQB test script will be applied to the test tool from the vendor of TLF3000, and run the test. All of the test items should pass with BQB RF-PHY criteria.

Pre-BQB Test Setup

See Figure 1.

Pre-BQB Test items and specifications

Test Items		Test Specifications	Test Condition
Transmitter Test	Output Power	RFPHY/TRM/BV-01	EOC
	In-band Emission	RFPHY/TRM/BV-03, 08	NOC
	Modulation Characteristics	RFPHY/TRM/BV-05, 10, 13	EOC
	Carrier Frequency offset and drift	RFPHY/TRM/BV-06, 12, 14	EOC
Receiver Test	Receiver Sensitivity	RFPHY/RCV/BV-01, 08, 26, 27	EOC
	C/I and Receiver Selectivity	RFPHY/RCV/BV-03, 09, 28, 29	NOC
	Blocking performance	RFPHY/RCV/BV-04, 10	NOC
	Intermodulation	RFPHY/RCV/BV-05, 11	NOC
	Maximum Input Signal level	RFPHY/RCV/BV-06, 12	EOC
	PER Report Integrity	RFPHY/RCV/BV-07, 13, 30, 31	EOC

Table 23 - Pre-BQB Test Items and Specifications

Pre-BQB Test Result

- Pass.

2.4 Power Consumption

The purpose of this section is to evaluate the ATM3325 Tag reference design performance in application mode.

2.4.1 Current Consumption

This test verifies the current consumption baseline of DUT and makes sure DUT has no abnormal current consumption in each operation mode.

Items	Conditions
VDDIO	External VDDIO(connected to VBAT)
Temperature	25°C
Equipment	N6705C + BV9201B
SDK	5.4.0
Application	AOA_dir_finding_tag
FW update command	make clean CFG_REF_SENSOR:=1 run_all CFG_SOC_OFF_DEMO=1 SWDIF=FTDI BOARD=ATMEVK_3325_TAG SWDBOARD=DL

Table 24 - Current Consumption Test Conditions

Current Consumption Test Method

- Supply DC voltage for DUT by DC power analyzer, then record current consumption in different application modes, such as Beaconing, Retention, and SOC off. The detailed mode descriptions are shown below.
    - When the power to +BAT is on, the tag will start beaconing, and the green LED will blink 3 times.
    - When the tag is in beaconing mode, a single button press will stop the beaconing, and the system goes to SoC off mode. The red LED will blink 3 times.
    - When the tag is in SoC off mode, a single button press will start the beaconing, and the green LED will blink 3 times.
    - When the tag is in beaconing mode, it will go to SoC Off automatically to preserve battery power after 10 minutes.

Current Consumption Test Setup

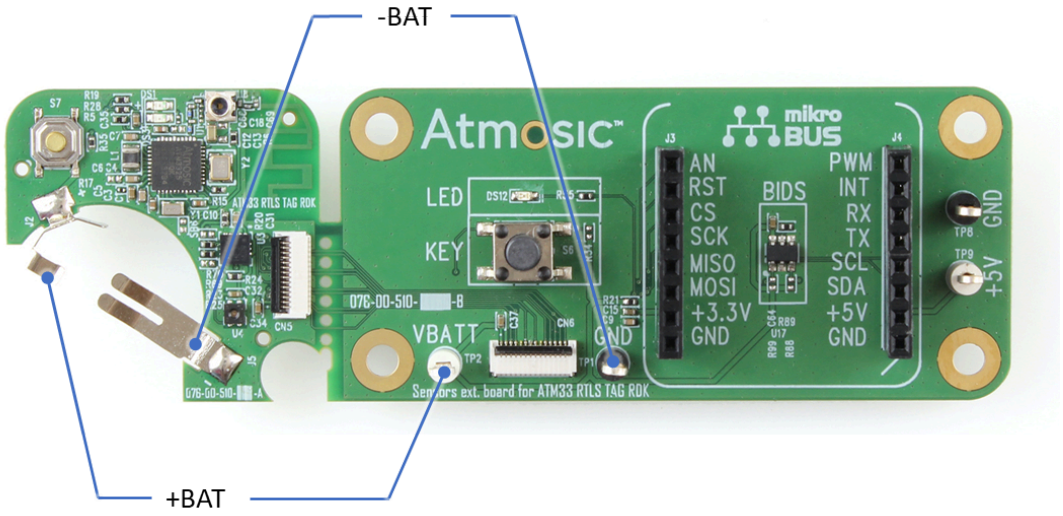


Figure 13 - Current Consumption Test Setup

Current Consumption Test Result

Test Condition

- External 32k, VBAT=3V

Mode	0dBm	4dBm	8dBm	10dBm
Beaconing	254.766 µA	291.58 µA	409.624 µA	492.131 µA
SoC off	1.575 µA	1.574 µA	1.626 µA	1.703 µA

Table 25 - Current Consumption of Tag with Application AOA_dir_finding_tag at 3V with external 32k.

- External 32k, VBAT=2V

Mode	0dBm	4dBm	8dBm	10dBm
Beaconing	330.656 µA	384.561 µA	558.469 µA	669.774 µA
SoC off	1.281 µA	1.278 µA	1.351 µA	1.36 µA

Table 26 - Current Consumption of Tag with Application AOA_dir_finding_tag at 2V with external 32k.

- Internal 32k, VBAT=3V

Mode	0dBm	4dBm	8dBm	10dBm
Beaconing	292.651 µA	330.248 µA	450.274 µA	543.151 µA
SoC off	1.636 µA	1.644 µA	1.644 µA	1.73 µA

Table 27 - Current Consumption of Tag with Application AOA_dir_finding_tag at 3V with internal 32k.

- Internal 32k, VBAT=2V

Mode	0dBm	4dBm	8dBm	10dBm
Beaconing	381.876 µA	437.998 µA	608.705 µA	731.132 µA
SoC off	1.372 µA	1.371 µA	1.388 µA	1.388 µA

Table 28 - Current Consumption of Tag with Application AOA_dir_finding_tag at 2V with internal 32k.

Notes:

1) *The test FW is based on SDK5.4.0 with an updated sensor driver for LIS3DH and AOA_dir_finding_tag.c. In the makefile add CFLAGS: -DVDDIO_TYPE=VDDIO_TYPE_INTERNAL*

2) *The AOA_dir_finding_tag will blink the green LED every 30s during the beaconing state.*

3) *The retention and SOC off currents consumption for 2V is lower than 3V due to the sensor having lower current consumption under a lower voltage supply.*

4) *It has much lower current consumption at 2V for Power-on/Power-off processes as the LED has almost no light at voltage 2V.*

5) *ENS210 is operating at single shot mode with 2s intervals, and LIS3DH is operating at 100 Hz.*

Reference Documents

Title	Document Number
ATM33/e Series Evaluation Kit User Guide	ATM33_e-UGEVK
ATM33 Series Datasheet	ATM33-DS
ATM3325 Tag Reference Design BQB Test Results	ATM3325-RTBQB
Over-The-Air Update Service User Guide	ATM-UGOTA
Reference Design Programming Board User Guide	ATM-UGRPB
RF Test Tool User Guide	ATM-UGRF
SDK User Guide	ATM-UGSDK

Revision History

Date	Version	Description
March 29, 2024	0.51	Updated 2.3.3 Conducted Band Edge, Figure 10 - Conducted Harmonic Test Setup, and Table 16 - FCC Pre-test (Radiated Harmonic) Test…
August 10, 2023	0.50	Initial version created.

ATMOSIC TECHNOLOGIES – DISCLAIMER

This product document is intended to be a general informational aid and not a substitute for any literature or labeling accompanying your purchase of the Atmosic product. Atmosic reserves the right to amend its product literature at any time without notice and for any reason, including to improve product design or function. While Atmosic strives to make its documents accurate and current, Atmosic makes no warranty or representation that the information contained in this document is completely accurate, and Atmosic hereby disclaims (i) any and all liability for any errors or inaccuracies contained in any document or in any other product literature and any damages or lost profits resulting therefrom; (ii) any and all liability and responsibility for any action you take or fail to take based on the information contained in this document; and (iii) any and all implied warranties which may attach to this document, including warranties of fitness for particular purpose, non-infringement and merchantability. Consequently, you assume all risk in your use of this document, the Atmosic product, and in any action you take or fail to take based upon the information in this document. Any statements in this document in regard to the suitability of an Atmosic product for certain types of applications are based on Atmosic's general knowledge of typical requirements in generic applications and are not binding statements about the suitability of Atmosic products for any particular application. It is your responsibility as the customer to validate that a particular Atmosic product is suitable for use in a particular application. All content in this document is proprietary, copyrighted, and owned or licensed by Atmosic, and any unauthorized use of content or trademarks contained herein is strictly prohibited.

Atmosic™

Atmosic Technologies | 2105 S. Bascom Ave. | Campbell CA, 95008
www.atmosic.com