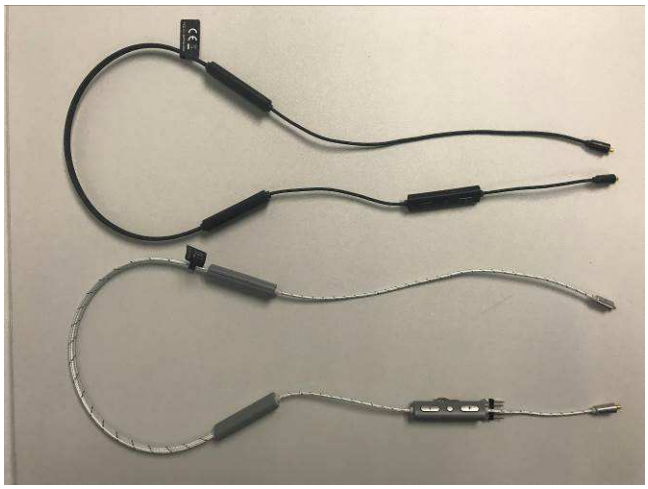
Prüfbericht-Nr.: *Test Report No.*:	**50182826 001**	**Auftrags-Nr.:** *Order No.*:	**144195597**	**Seite 1 von 19** *Page 1 of 19*
Kunden-Referenz-Nr.: *Client Reference No.*:	**N/A**	**Auftragsdatum:** *Order date*:	**13.09.2018**	
Auftraggeber: *Client*:	**Shinola Detroit LLC** **485 W Milwaukee St Ste 501, Detroit, MI 48202-3220, USA**			
Prüfgegenstand: *Test item*:	**Bluetooth Earphone**			
Bezeichnung / Typ-Nr.: *Identification / Type No.*:	**IEM TETHER**			
Auftrags-Inhalt: *Order content*:	**FCC Certification**			
Prüfgrundlage: *Test specification*:	**FCC Part 15 Subpart C** **ANSI C63.10-2013**			
Wareneingangsdatum: *Date of receipt*:	**11.10.2018**			
Prüfmuster-Nr.: *Test sample No.*:	**A000820234-001**			
Prüfzeitraum: *Testing period*:	**18.10.2018 - 31.10.2018**			
Ort der Prüfung: *Place of testing*:	**TÜV Rheinland Hong Kong Ltd.**			
Prüflaboratorium: *Testing laboratory*:	**TÜV Rheinland Hong Kong Ltd.**			
Prüfergebnis*: *Test result**:	**Pass**			



geprüft von / *tested by*:			**kontrolliert von /** *reviewed by*:		
03.11.2018	Mika Chan / Project Manager		03.11.2018	Sharon Li / Senior Unit Manager	
Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*	**Datum** *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*

Sonstiges / *Other*: **FCC ID: 2APOA-IEM003**

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery*:	Prüfmuster vollständig und unbeschädigt *Test item complete and undamaged*

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Table of Content

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Product information

Manufacturers declarations

	Transmitter
Operating frequency range	2402 - 2480 MHz
Type of modulation	GFSK; Pi/4 DQPSK; 8 DPSK
Number of channels	79
Channel separation	1 MHz
Type of antenna	Ceramic Antenna
Antenna gain (dBi)	2.64 dBi
Power level	fix
Type of equipment	stand alone radio device
Connection to public utility power line	Yes
Nominal voltage	3.7 VDC
Independent Operation Modes	Transmitting

Product function and intended use

The equipment under test (EUT) is an in ear earphone with Bluetooth connectivity. It is powered by 3.7 VDC battery.

FCC ID: 2APOA-IEM003

Models	Product description
IEM TETHER	Bluetooth Earphone

Submitted documents

Circuit Diagram
Block Diagram
Technical Description
User manual
Label

Independent Operation Modes

The basic operation modes are:

- Transmitting mode.
- Normal operation mode

For further information refer to User Manual

Related Submittal(s) Grants

This is a single application for certification of the Bluetooth transmitter.

Remark

The test results in this test report are only relevant to the tested sample and does not involve any assessment in the production.

Test Set-up and Operation Mode

Principle of Configuration Selection

Emission: The equipment under test (EUT) was configured to measure its highest possible radiation level. The test modes were adapted accordingly in reference to the instructions for use.

Test Operation and Test Software

Test operation should refer to test methodology.

- During test, Channel & Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power was selected according to the instruction given by the manufacturer. The setting of the RF output power expected by the customer shall be fixed on the firmware of the final end product.

Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

- NIL

Countermeasures to achieve EMC Compliance

- NIL

Test Methodology

Radiated Emission

The radiated emission measurements of the transmitter part were performed according to the procedures in ANSI C63.10-2013.

For measurement below 1GHz - the equipment under test (EUT) was placed at the middle of the 80 cm height turntable. For measurement above 1GHz - the EUT was placed at the middle of the 1.5 m height turntable and RF absorbing material was placed on ground plane between turntable and measuring antenna. During the testing, the EUT was operated standalone and arranged for maximum emissions. The EUT was tested in three orthogonal planes.

The investigation is performed with the EUT rotated 360 ° , the antenna height scanned between 1m and 4m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Repeat the measurement steps until the maximum emissions were obtained.

All radiated tests were performed at an antenna to EUT with 3 meters distance, unless stated otherwise in particular parts of this test report.

Field Strength Calculation

The field strength at 3 m was established by adding the meter reading of the spectrum analyzer to the factors associated with antenna correction factor, cable loss, preamplifiers and filter attenuation.

The equation is expressed as follow:

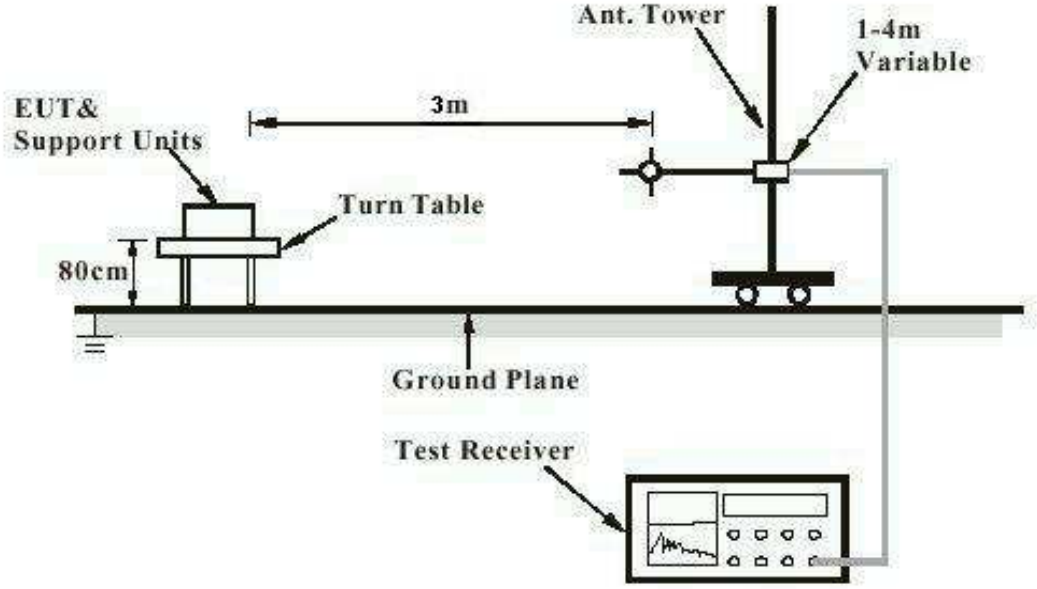
FS = R + AF + CF + FA – PA

Where FS = Field Strength in dBuV/m at 3 meters.
R = Reading of Spectrum Analyzer in dBuV.
AF = Antenna Factor in dB.
CF = Cable Attenuation Factor in dB.
FA = Filter Attenuation Factor in dB.
PA = Preamplifier Factor in dB.

FA and PA are only be used for the measuring frequency above 1 GHz.

Test Setup Diagram

Diagram of Measurement Configuration for Radiation Test



Note: Measurements above 1 GHz are done with a table height of 1.5m. In addition, there is RF absorbing material on the floor of the test site for above 1GHz measurement.

Diagram of Measurement Equipment Configuration for Mains Conduction Measurement (if applicable)

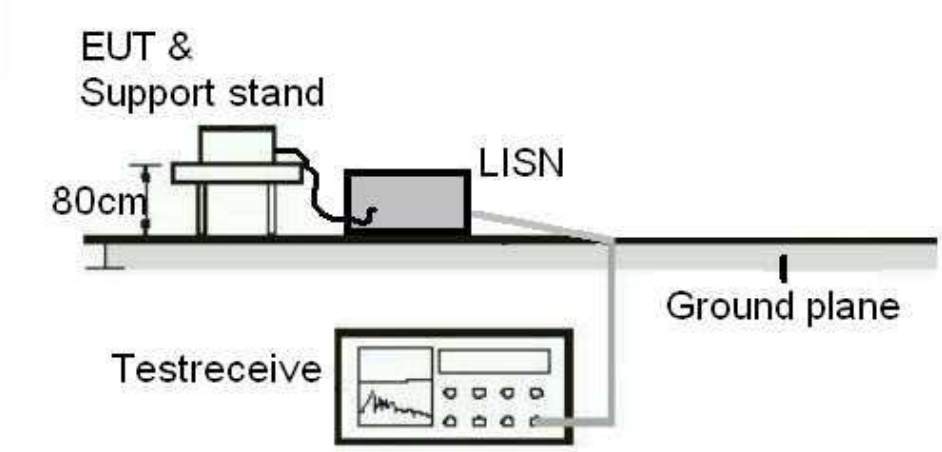
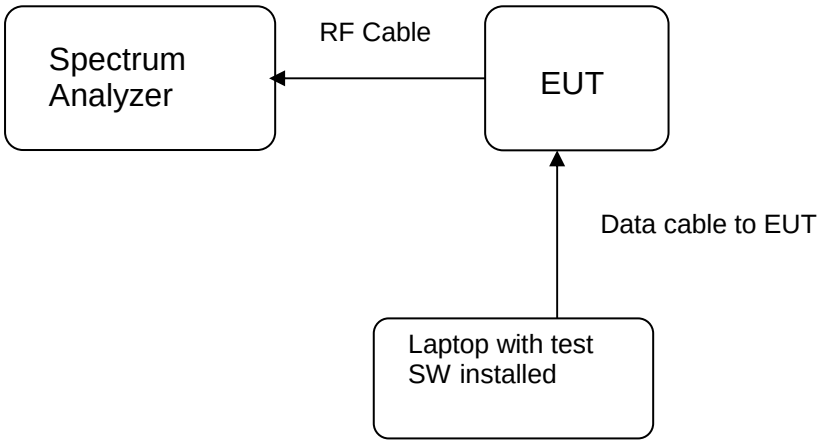


Diagram of Equipment Configuration for Antenna-port Conducted Measurement (if applicable)


Spectrum Analyzer
RF Cable
EUT
Data cable to EUT
Laptop with test SW installed

Test Facility

Test Laboratory Information

TÜV Rheinland Hong Kong Ltd.
Address: 3-4, 11/F., Fou Wah Industrial Building, 10-16 Pun Shan Street, Tsuen Wan, N.T., Hong Kong·
Tel.: +852 2192 1000
Fax: +852 2192 1001
Email service-gc@tuv.com
Web: www.tuv.com

The test facility is recognized or accredited by the following organizations:

FCC

Type	: Accredited Test Firm
Designation Number	: HK0013
Test Firm Registration Number	: 371735
Scope	: Intentional Radiators

List of Test and Measurement Instruments

Radiated Emission

Equipment	Manufacturer	Type	Cal. Date	Due Date
Semi-anechoic Chamber	Frankonia	Nil	23-Apr-18	23-Apr-19
Test Receiver	R & S	ESU40	12-Jun-18	12-Jun-19
Active Loop Antenna	EMCO	6502	30-Oct-17	30-Oct-18
Bi-conical Antenna	R & S	HK116	21-Mar-18	21-Mar-20
Log Periodic Antenna	R & S	HL223	22-Mar-18	22-Mar-20
Horn Antenna	EMCO	3115	28-Mar-18	28-Mar-20
Coaxial cable	Huber+Suhner	CNM-NMCMILX800-473	11-Dec-17	11-Dec-19
High Frequency Cable	Huber+Suhner	CNM-NMCMILX800-473	11-Dec-17	11-Dec-19
Microwave amplifer 0.5-26.5GHz, 25dB gain	HP	83017A	18-Jul-17	18-Jul-19
Preamplifier 18GHz to 40GHz with cable	A.H. Systems, Inc.	PAM-1840VH	29-Jan-18	29-Jan-19
High Pass Filter (cutoff freq. =1000MHz)	Trilithic	23042	30-Oct-17	30-Oct-19

Radio Test

Equipment	Manufacturer	Type	Cal. Date	Due Date
Spectrum Analyzer	R & S	FSP30	03-May-18	02-May-19

Measurement Uncertainty

The estimated combined standard uncertainty for power-line conducted emissions measurements is ±2.42dB.

The estimated combined standard uncertainty for radiated emissions measurements is ±4.81dB (9kHz to 30MHz) and ±4.62dB (30MHz to 200MHz) and ±5.67dB (200MHz to 1000MHz) and is ±5.07dB (1GHz to 8.2GHz) and ±4.58dB (8.2GHz to 12.4GHz) and ±4.78dB (12.4GHz to 18GHz)

The estimated combined standard uncertainty for antenna conducted emission is ±2.1dB

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor of k=2, which for the level of confidence is approximately 95%.

Results FCC Part 15 – Subpart C

FCC 15.203 – Antenna Requirement 1		**Pass**
FCC Requirement:	No antenna other than that furnished by the responsible party shall be used with the device	
Results:	a) Antenna type: b) Manufacturer and model no: c) Peak Gain:	Fixed Integral Ceramic Antenna Walsin Technology / RFECA3216060A1T 2.64 dBi
Verdict:	Pass	

FCC 15.204 – Antenna Requirement 2	**Pass**
FCC Requirement:	An intentional radiator may be operated only with the antenna with which it is authorized. If an antenna is marketed with the intentional radiator, it shall be of a type which is authorized with the intentional radiator.
Results:	Only one integral antenna can be used.
Verdict:	N/A

FCC 15.207 – Conducted Emission on AC Mains	**Pass**
There is no AC power input or output ports on the EUT.	

FCC 15.247 (b)(1) – Peak Output Power	**Pass**
Test Specification : ANSI C63.10 – 2013 Test date : 31.10.2018 Mode of operation : Tx mode Port of testing : Temporary antenna port Supply voltage : 3.7VDC Temperature : 23ºC Humidity : 50%	
FCC Requirement : For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 Watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 Watts.	
Results:	For test protocols please refer to Appendix 1.

Frequency (MHz)	**Maximum peak output power (dBm)**	**Limit (W/dBm)**	**Verdict**
2402	6.63	0.125 / 21.0	Pass
2441	7.21	0.125 / 21.0	Pass
2480	6.30	0.125 / 21.0	Pass

FCC 15.247 (a) – 20 dB Bandwidth **Pass**

FCC Requirement: N/A

Test Specification : ANSI C63.10 – 2013
Test date : 31.10.2018
Mode of operation : Tx mode
Port of testing : Temporary antenna port
Supply voltage : 3.7VDC
Temperature : 23ºC
Humidity : 50%

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.

For test protocols refer to Appendix 1.

Frequency (MHz)	20 dB left (MHz)	20 dB right (MHz)	20dB bandwidth (MHz)
2402	2401.32	2402.60	1.28
2441	2440.32	2441.60	1.28
2480	2479.32	2480.60	1.28

FCC 15.247(a)(1)– Carrier Frequency Separation **Pass**

FCC Requirement:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 2/3*20dB bandwidth of the hopping channel, whichever is greater.

Test Specification : ANSI C63.10 – 2013
Test date : 31.10.2018
Mode of operation : Tx mode (hopping on)
Port of testing : Temporary antenna port
Supply voltage : 3.7VDC
Temperature : 23ºC
Humidity : 50%

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.

For test Results plots refer to Appendix 1.

Channel Separation (kHz)	Limit (kHz)	Verdict
1064	853	Pass

FCC 15.247 (a)(1)(iii)– Number of hopping channels	**Pass**

FCC Requirement:

Frequency hopping systems operating in the 2400MHz-2483.5MHz bands shall use at least 15 hopping frequencies.

Test Specification : ANSI C63.10 – 2013
Test date : 31.10.2018
Mode of operation : Tx mode (hopping on)
Port of testing : Temporary antenna port
Supply voltage : 3.7VDC
Temperature : 23ºC
Humidity : 50%

Results: For test Results plots refer to Appendix 1.

No. of hopping channels	Limit	Verdict
79	15	Pass

FCC 15.247 (a)(1)(iii) – Time of Occupancy (Dwell Time)	**Pass**

FCC Requirement:

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test Specification : ANSI C63.10 – 2013
Test date : 31.10.2018
Mode of operation : Tx mode (hopping on)
Port of testing : Temporary antenna port
Supply voltage : 3.7VDC
Temperature : 23ºC
Humidity : 50%

Results: Time period calculation = 0.4 x 79 = 31.6s

Dwell time = 64 x 2.90 x 10^{-3} = 0.186 s
<= 0.4 s

For test protocols please refer to Appendix 1.

Verdict: Pass

FCC 15.247 (a) – Hopping Sequence	**Pass**
FCC Requirement:	The system radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, while the long-term distribution appears evenly distributed.
Refer to Bluetooth Specification	

FCC 15.247 (a) – Equal Hopping Frequency Use	**Pass**
FCC Requirement:	Each of the transmitter's hopping channels is used equally on average. The system radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, while the long-term distribution appears evenly distributed.
Refer to Bluetooth Specification	

FCC 15.247 (a) – Receiver Input Bandwidth	**Pass**
FCC Requirement:	The associated receiver(s) complies with the requirement that its input bandwidth matches the bandwidth of the transmitted signal.
Refer to Bluetooth Specification	

FCC 15.247 (a) – Receiver Hopping Capability	**Pass**
FCC Requirement:	The associated receiver has the ability to shift frequencies in synchronisation with the transmitted signals.
Refer to Bluetooth Specification	

FCC 15.247 (d) – Spurious Conducted Emissions	**Pass**

Test Specification : ANSI C63.10 – 2013
Test date : 31.10.2018
Mode of operation : Tx mode
Port of testing : Temporary antenna port
Supply voltage : 3.7VDC
Temperature : 23 ºC
Humidity : 50 %

FCC Requirement: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.

There is no peak found outside any 100kHz bandwidth of the operating frequency band in the three transmit frequency. All three transmit frequency modes comply with the limit stated in subclause 15.247(d). For test protocols refer to Appendix 1.

Operating frequency (MHz)	Spurious frequency (MHz)	Spurious Level (dBm)	Reference value (dBm)	Delta (dB)	Verdict
2402	2399.640	-31.98	6.41	38.39	Pass
2441	24328.000	-30.68	6.92	37.60	Pass
2480	24280.000	-30.63	5.94	36.57	Pass

FCC 15.205– Radiated Emissions in Restricted Frequency Bands **Pass**

Test Specification : ANSI C63.10 – 2013
Test Date : 25.10.2018
Mode of operation : Tx mode
Port of testing : Enclosure
Frequency range : 9kHz – 25GHz
Supply voltage : 3.7VDC
Temperature : 23ºC
Humidity : 50%

FCC Requirement: In any 100kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands, as defined in section15.205(a), must also comply with the radiated emission limits specified in section 15.205(c).

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and data rate.

All three transmit frequency modes comply with the field strength within the restricted bands. There is no spurious found below 30MHz.

Mode: 2402 MHz TX Vertical Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
2390.000	67.7	74.0 / PK
2390.000	26.6	54.0 / AV
4803.954	54.6	74.0 / PK
4803.954	52.7	54.0 / AV
7205.931	51.1	74.0 / PK
7205.931	46.3	54.0 / AV
9607.908	49.4	74.0 / PK
9607.908	42.5	54.0 / AV

Mode: 2402 MHz TX Horizontal Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
2390.000	59.6	74.0 / PK
2390.000	24.7	54.0 / AV
4803.955	54.1	74.0 / PK
4803.955	52.2	54.0 / AV

Mode: 2441 MHz TX Vertical Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4883.951	54.4	74.0 / PK
4883.951	52.5	54.0 / AV
7325.927	48.3	74.0 / PK
4883.951	41.1	54.0 / AV

Mode: 2441 MHz TX Horizontal Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4883.951	62.6	74.0 / PK

4883.951	51.6	54.0 / AV
7325.927	52.6	74.0 / PK
7325.927	48.2	54.0 / AV
Mode: 2480 MHz TX	Vertical Polarization	
Freq MHz	**Level dBuV/m**	**Limit/ Detector dBuV/m**
2483.500	48.8	74.0 / PK
2483.500	29.5	54.0 / AV
4959.625	60.9	74.0 / PK
4959.625	47.4	54.0 / AV
Mode: 2480 MHz TX	Horizontal Polarization	
Freq MHz	**Level dBuV/m**	**Limit/ Detector dBuV/m**
2483.500	66.8	74.0 / PK
2483.500	45.1	54.0 / AV
4959.628	61.8	74.0 / PK
4959.628	48.3	54.0 / AV
7439.439	49.9	74.0 / PK
7439.439	35.7	54.0 / AV