RF Exposure Evaluation
FCC ID: 2A2V6-FZ
IC: 27624-FZ

1. Client Information

Applicant	:	Flipper Devices Inc
Address	:	2803 Philadelphia Pike, Suite B #551 Claymont, DE 19703, USA
Manufacturer	:	Flipper Devices Inc
Address	:	2803 Philadelphia Pike, Suite B #551 Claymont, DE 19703, USA

2. General Description of EUT

EUT Name	:	Flipper Zero	
HVIN/Model(s) No.	:	FZ.1	
Model Different	:	N/A	
Sample ID	:	20210916-08-1#& 20210916-08-2#	
Product Description	:	Operation Frequency:	Bluetooth 5.2: 2402MHz~2480MHz Sub 1GHz: 304.5-321.95MHz 433.075-434.775MHz 915.00-927.95MHz NFC: 13.56MHz RFID: 125KHz
		Antenna Type:	Bluetooth: Ceramic Antenna(1.88 dBi) Sub 1GHz: Spring Antenna(-7 dBi) NFC&RFID: PCB Antenna(0 dBi)
Power Supply	:	USB Input: DC 5V1.0A or DC 3.7V by 2100mAh Rechargeable Li-ion battery	
Software Version	:	fw-0.40.1	
Hardware Version	:	12.F7B9C6	
Note: More test information about the EUT please refer the RF Test Report.			
Flipper Zero: Portable handheld electronic device featuring virtual pet, designed for education, development and prototyping of electronics and software.			

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The RF Exposure Evaluation for FCC:

SAR Test Exclusion Calculations

FCC: According to KDB 447498 D01 Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies v06.

(1) Clause 4.3: General SAR test reduction and exclusion guidance

Sub clause 4.31: Standalone SAR test exclusion considerations

1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6GHz at test separation distance≤5 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation, mm)]*[√f(GHz)] ≤3.0 for 1-g SAR

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation, mm)]*[√f(GHz)] ≤7.5.0 for 10-g SAR

Calculation:

Test separation: 5mm						
BLE Mode(1Mbps)						
Frequency (GHz)	Conducted Power (dBm)	Turn-up Power Tolerance (dB)	Max power of tune up tolerance (dBm)	Max power of tune up tolerance (mw)	Calculation Value	Threshold Value
2.402	3.73	3±1	4	2.512	0.779	**3.0**
2.440	3.64	3±1	4	2.512	0.785	**3.0**
2.480	3.54	3±1	4	2.512	0.791	**3.0**
BLE Mode(2Mbps)						
Frequency (GHz)	Conducted Power (dBm)	Turn-up Power Tolerance (dB)	Max power of tune up tolerance (dBm)	Max power of tune up tolerance (mw)	Calculation Value	
2.402	3.74	4±1	5	3.162	0.980	**3.0**
2.440	3.65	4±1	5	3.162	0.988	**3.0**
2.402	3.42	4±1	5	3.162	0.996	**3.0**

Frequency (MHz)	Max. Output Power (dBuV/m)	Max. Output Power (dBm)	Tolerance ± (dB)	Output power (Max. Turn-up Procedure) (mW)	Calculation Value	Threshold Value
304.5-321.95MHz	79.91	-20.05	-20±1	0.01259	0.0014	**3.0**
433.075-434.775MHz	73.73	-26.23	-26±1	0.00316	0.0004	**3.0**
915.00-927.95MHz	72.75	-27.20	-27±1	0.00251	0.0005	**3.0**
NFC: 13.56MHz	51.89	-49.37	-49±1	0.00002	0.0000004	**3.0**
RFID: 125KHz	50.74	-50.51	-50±1	0.00001	0.0000025	**3.0**

Note: For conducted measurements below 1000 MHz, the field strength shall be computed as specified in item d), and then an additional 4.7 dB shall be added as an upper bound on the field strength that would be observed on a test range with a ground plane for frequencies between 30 MHz and 1000 MHz, or an additional 6 dB shall be added for frequencies below 30 MHz.

$$E = \mathrm{EIRP} - 20 \log d + 104.8$$

where

E is the electric field strength in dBμV/m
EIRP is the equivalent isotropically radiated power in dBm
d is the specified measurement distance in m

So: EIRP=E+20log3-104.8-(4.7 or 6)

Note: At separation distance of ≤5 mm

Simultaneous Transmission for SAR Exclusion

The sample support BLE/SRD/NFC/RFID function, they supports difference antenna, need consider simultaneous transmission;

$\sum$ of (the highest measured or estimated SAR_{BLE}+SAR_{SRD}+ SAR_{NFC})/1.6 = (0.1333+0.0002+ 0.0000002)/1.6 = 0.08 < 1.0;

The RF Exposure Evaluation for IC:

SAR Test Exclusion Calculations

IC: According to RSS-102 — Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands) Issue 5: March 19, 2015

(2) Clause 2.5.1: Exemption limits for Routine Evaluation – SAR Evaluation

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

Table 1: SAR evaluation — Exemption limits for routine evaluation based on frequency and separation distance

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ⩽5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Table 1: SAR evaluation — Exemption limits for routine evaluation based on frequency and separation distance

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ⩾50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

Calculation:

BLE							
Mode	Frequency (MHz)	Conducted Output Power (dBm)	Gain (dBi)	E.I.R.P. (dBm)	Tolerance ± (dB)	Output power (Max. Turn-up Procedure) (mW)	Limit (mW)
1Mbps	2402	3.73	1.88	5.61	5.0±1	3.1623	4
	2440	3.64	1.88	5.52	5.0±1	3.1623	4
	2480	3.54	1.88	5.42	5.0±1	3.1623	4
2Mbps	2402	3.74	1.88	5.62	5.0±1	3.1623	4
	2440	3.65	1.88	5.53	5.0±1	3.1623	4
	2480	3.42	1.88	5.30	5.0±1	3.1623	4

Frequency (MHz)	Max. Output Power (dBuV/m)	Max. Output Power (dBm)	Tolerance ± (dB)	Output power (Max. Turn-up Procedure) (mW)	Limit (mW)
304.5-321.95MHz	79.91	-20.05	-20±1	0.01259	52
433.075-434.775MHz	73.73	-26.23	-26±1	0.00316	52
915.00-927.95MHz	69.49	-30.47	-30±1	0.00126	17
NFC: 13.56MHz	51.89	-49.37	-49±1	0.00002	71
RFID: 125KHz	50.74	-50.51	-50±1	0.00001	71

Note:
For conducted measurements below 1000 MHz, the field strength shall be computed as specified in item d), and then an additional 4.7 dB shall be added as an upper bound on the field strength that would be observed on a test range with a ground plane for frequencies between 30 MHz and 1000 MHz, or an additional 6 dB shall be added for frequencies below 30 MHz.

$$E = \mathrm{EIRP} - 20\log d + 104.8$$

where

E is the electric field strength in dBμV/m
EIRP is the equivalent isotropically radiated power in dBm
d is the specified measurement distance in m

So: EIRP=E+20log3-104.8-(4.7 or 6)

Note: At separation distance of ≤5 mm

Simultaneous Transmission for SAR Exclusion

The sample support BLE/SRD/NFC/RFID function, they supports difference antenna, need consider simultaneous transmission;
(maximum power level including tune-up tolerance for transmitter A / maximum power level of exemption at the same frequency and distance) * 0.4W/kg.(watts per kilogram)
BLE max tune-up is 6.0dBm=3.981mW,
SRD max tune-up is -19.0dBm=0.01259mW,
NFC Max tune-up is -48dBm=0.00002 mW
The BLE estimated Sar=(3.981Mw/4mW)*0.4W/kg=0.3981W/kg
The SRD estimated Sar=(0.01259Mw/4mW)*0.4W/kg=0.001259W/kg
The NFC estimated Sar=(0.00002mW/4mW)*0.4W/kg=0.000002W/kg
∑ of (the highest measured or estimated SAR_{BLE} + SAR_{NFC} + SAR_{SRD})= 0.3981 W/kg +0.000002W/kg + 0.001259W/kg =0.399361 W/kg<0.4W/kg

Conclusion:

The measurement results comply with the FCC Limit per 47 CFR 2.1093 and the RSS-102§4 Table 4 for the uncontrolled RF Exposure and SAR Exclusion Threshold per KDB 447498 v06, No SAR is required.

RF Exposure Considerations for RFID

Measuring Standard

RSS-102 Issue 5 March 2015: Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

SPR-002 Issue 1 September 2016: Supplementary Procedure for Assessing Compliance with RSS-102 Nerve Stimulation Exposure Limits.

SAFETY CODE 6 2015: LIMITS OF HUMAN EXPOSURE TO RADIOFREQUENCY ELECTROMAGNETIC ENERGY IN THE FREQUENCY RANGE FROM 3KHZ to 300GHz

Notice 2020 - DRS0012: Clarification on requirements set forth in issue 1 of SPR-002

Requirements

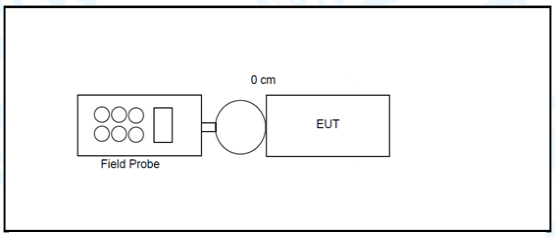
According to SPR-002 Issue 2 Supplementary Procedure for Assessing Compliance with RSS-102 Nerve Stimulation Exposure Limits section 6.5, system operating under the provisions of this section shall be operating in a manner that the public is not exposed to radio frequency energy level in excess limit for maximum permissible exposure.

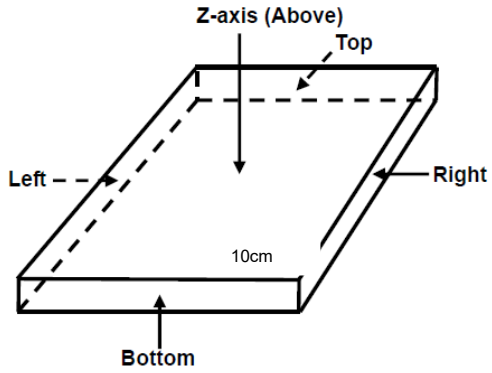
Table 2- Limb Exposure Limit Relaxation

Exposure Condition	Relaxation Factor	Electric Filed (V/m r.m.s)	Magnetic Field (A/m r.m.s)
Whole Body/Torso/Head	1.0	82	90
Leg	1.5	123.2	134
Arm	2.5	206.4	226
Hand/Foot	5.0	414	451

Note: The values of the electric field and the magnetic field in table 2 are for indication purposes only and do not supersede the levels specified in RSS-102.

Test Setup





Note: Measurements should be made from all sides and the top of the primary/client pair, with the 0 cm measured from the center of the probe(s) to the edge of the device.

Test Equipment List

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Due Date
Magnetic field meter	NARDA	ELT-400	EE030	Aug. 27, 2021	Sep. 26, 2022
Magnetic field probe	NARDA	ELT- probe 100cm2	EE034	Aug. 27, 2021	Sep. 26, 2022
Field intensity probe	NARDA	EP-601	511WX60706	Jun. 05, 2021	Jun. 04, 2022

Measurement Uncertainty

The reported uncertainty of measurement y ± U，where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2，providing a level of confidence of approximately 95 %.

Test Item	Parameters	Uncertainty
Field Strength Uncertainty	1Hz~400KHz	1%

Characterization for frequency range reduction

The default frequency range of ETL-400 is 30Hz~400kHz, As per test plot in clause 7.7 of report TB-RF185808. All Emission in frequency range of 400kHz to 10MHz is below 20dBc, thus conform the situation for test frequency range reduction.

Description of Test Quantities

According to Clause 4.3 of SPR-002 issue1, E-field and H-field should be tested for NS evaluation, while ETL-400 can only measure Magnetic field density(B), following calculation is applied for convert Magnetic field density to H-filed:
H-field(A/m)=B(uT)/1.25
A Broadband Electric Field Probe was used for measuring E-field directly.

Test Result

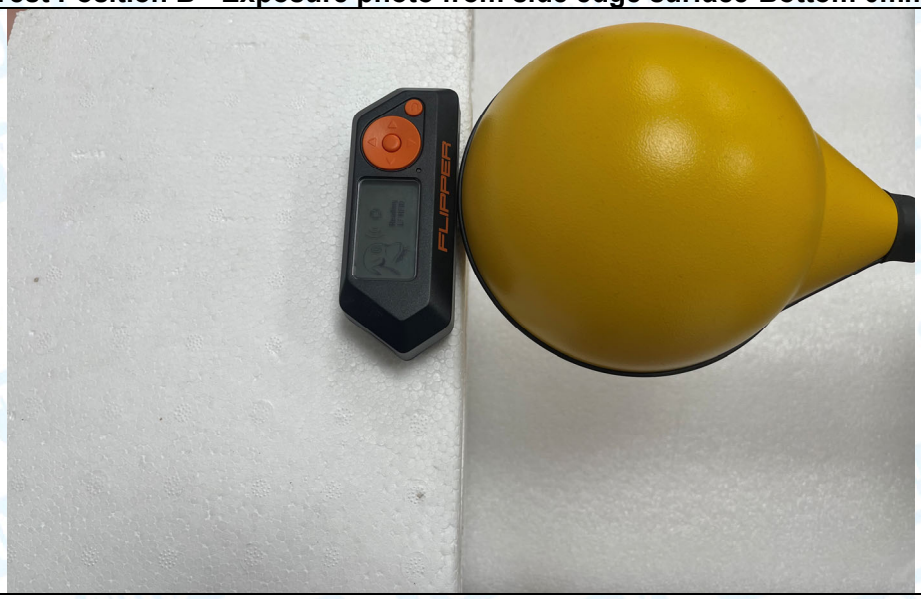
E-Field Measurement (0cm)						
EUT Side	**Left**	**Right**	**Top**	**Bottom**	**Z-axis (Above)**	**Z-axis (Below)**
Max E-field (V/m)	1.46	1.58	1.75	1.88	1.36	2.56
Limit 83 (V/m)	83	83	83	83	83	83
Result	PASS	PASS	PASS	PASS	PASS	PASS

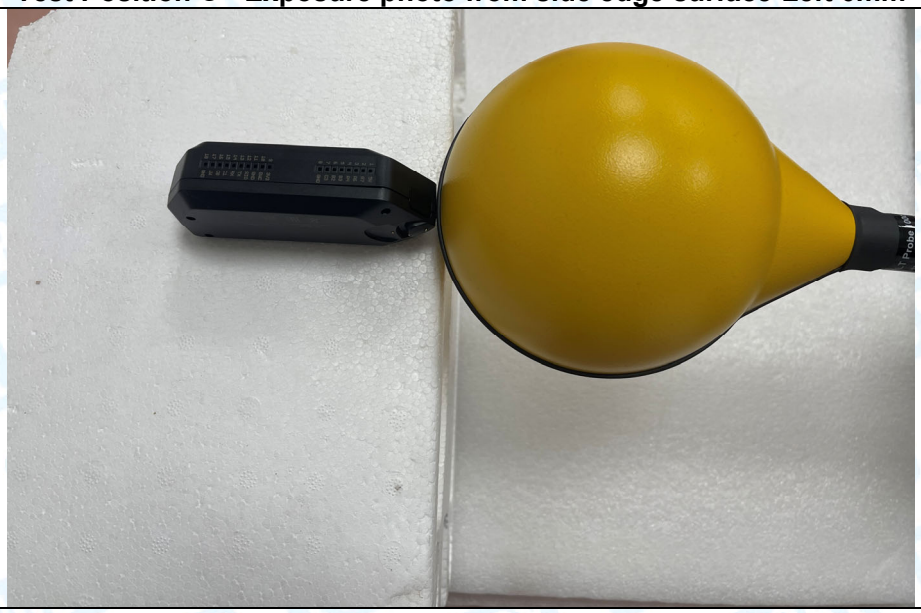
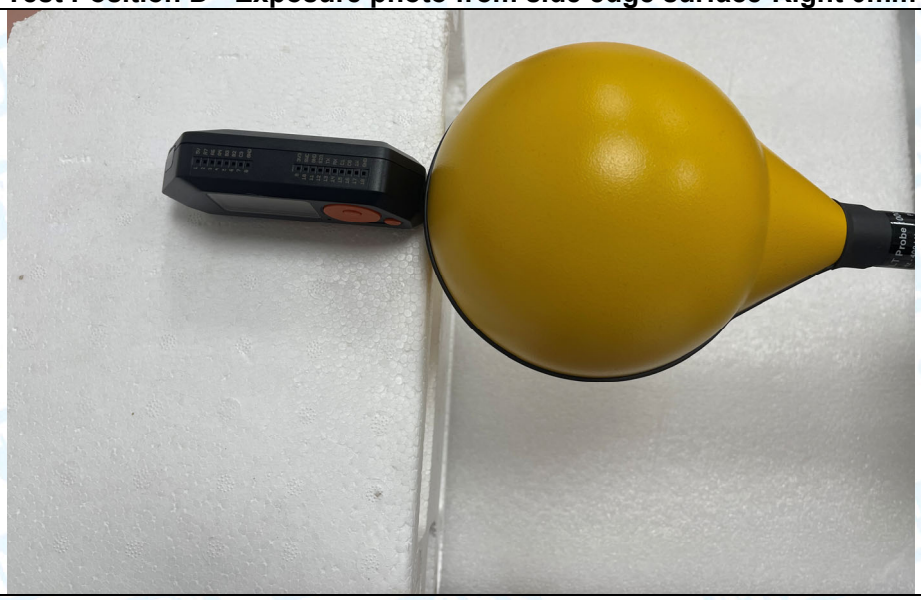
H-Field Measurement (0cm)						
EUT Side	**Left**	**Right**	**Top**	**Bottom**	**Z-axis (Above)**	**Z-axis (Below)**
Max H-field (uT)	0.240	0.266	0.376	0.415	0.312	1.949
Max H-field (A/m)	0.1920	0.2128	0.3008	0.3320	0.2496	1.5592
Limit 90 (A/m)	90	90	90	90	90	90
Result	PASS	PASS	PASS	PASS	PASS	PASS

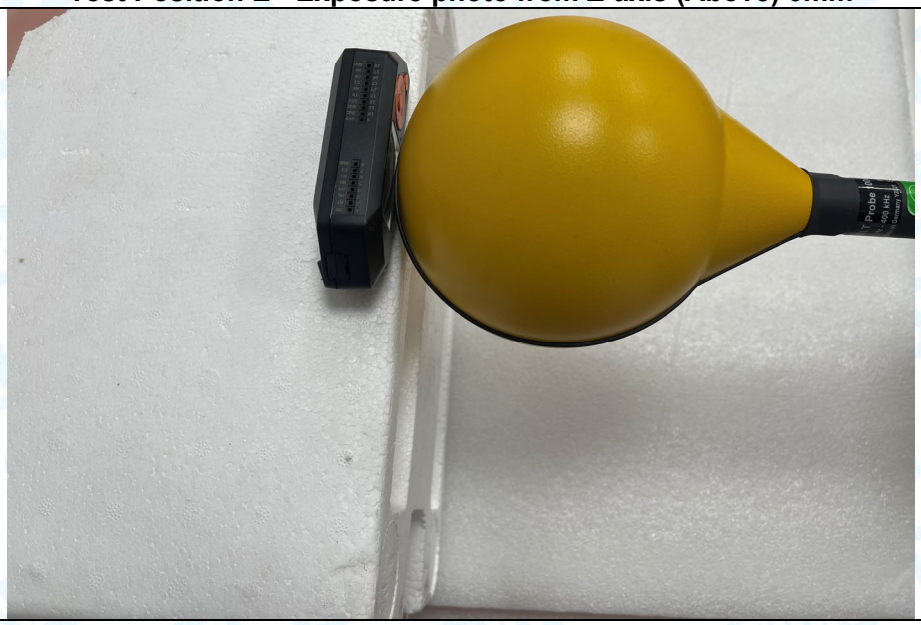
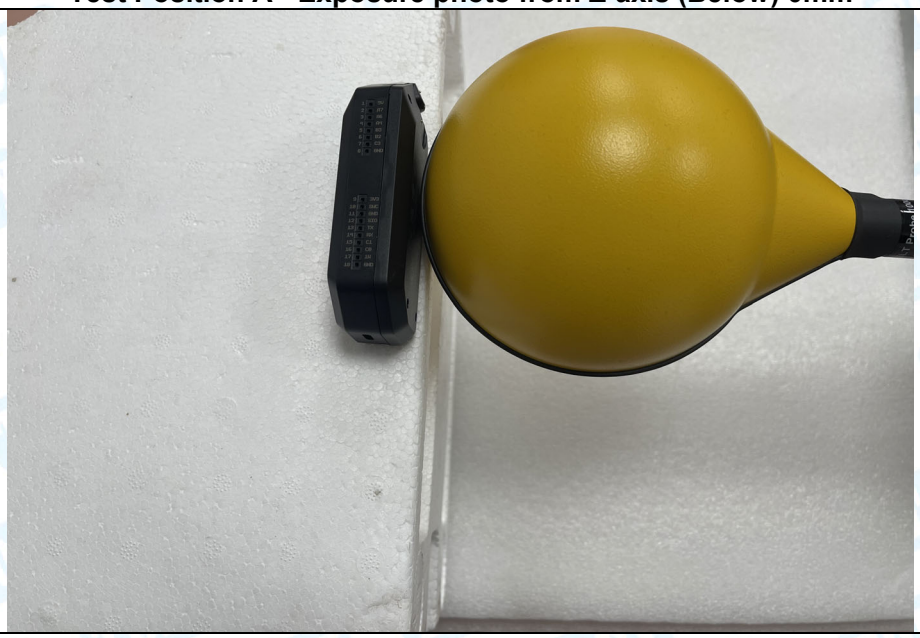
Measurements was made from all sides and the top of the primary/client pair, with the 0 cm measured from the center of the probe(s) to the edge of the device. The highest emission level was recorded.

Test Set-up Photo

H-Field Strength
Test Position A - Exposure photo from side edge surface-Top 0mm

H-Field Strength
Test Position B - Exposure photo from side edge surface-Bottom 0mm


H-Field Strength
Test Position C - Exposure photo from side edge surface-Left 0mm

H-Field Strength
Test Position D - Exposure photo from side edge surface-Right 0mm


H-Field Strength
Test Position E - Exposure photo from Z-axis (Above) 0mm

H-Field Strength
Test Position A - Exposure photo from Z-axis (Below) 0mm


E-Field Strength
Test Position A - Exposure photo from side edge surface-Top 0mm

E-Field Strength
Test Position B - Exposure photo from side edge surface-Bottom 0mm


E-Field Strength
Test Position C - Exposure photo from side edge surface-Left 0mm

E-Field Strength
Test Position D - Exposure photo from side edge surface-Right 0mm


E-Field Strength
Test Position E - Exposure photo from Z-axis (Above) 0mm

E-Field Strength
Test Position A - Exposure photo from Z-axis (Below) 0mm


-----END OF REPORT-----