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Test Report

Prepared for:	**KoreLock, Inc.**
Address:	**7100 E. Bellevue Ave. Suite 203 Greenwood Village, CO 80111 USA**
Product:	**KIC Select series locks**
Test Report No:	**R20240322-70-E2F**
Approved By:	

Fox Lane
EMC Test Engineer

DATE:	**28 October 2024**
Total Pages:	**15**

ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

Revision Page

Rev. No.	Date	Description
0	16 July 2024	Issued by FLane Reviewed by KVepuri Prepared by FLane
A	30 July 2024	Updated model- FL
B	7 August 2024	Checked settings - FL
C	12 August 2024	Updated Model Name - FL
D	15 August 2024	Updated model name - FL
E	9 September 2024	Removed text in purpose of test Added Frequency Error test - FL
F	28 October 2024	Added Band edge/OBW/Field Strength – FL

TABLE OF CONTENTS

1 Summary of Test Results

Summary of test results presented in this report correspond to the following section(s):

1.1 Emissions Test Results

The EUT was tested for compliance to:

US CFR Title 47 FCC Part 15.225
RSS-210 Issue 11

Table 1 – Emissions Test Results

Emissions Tests	Test Method and Limits	Result
Radiated Emissions	FCC Part 15.225 (a), (b), (c), (d) RSS-Gen, Issue 5, 6.5, 6.13 RSS-210 Issue 11 B.6	Complies
Bandedge	FCC Part 15.225 (b) (c) RSS-210 Issue 11 B.6(a)	Complies
Frequency Error	FCC Part 15.225(e) RSS-210 Issue 11 B.6(b)	Complies

2 EUT Description

2.1 Equipment under Test (EUT)

Table 2 – Equipment under Test (EUT)

EUT	KIC Select series locks
FCC ID	2BBNS-KLKIC
EUT Received	13 February 2023
EUT Tested	31 May 2024- 7 June 2024
Serial No.	011633 (NCEE Assigned Serial number)
Operating Band	13.56MHz
Device Type	☐ GMSK ☐ GFSK ☐ BT BR ☐ BT EDR 2MB ☐ BT EDR 3MB ☐ 802.11x ☒ NFC
Power Supply / Voltage	Internal Batteries 4xAA batteries

2.2 Laboratory Description

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

A2LA Certificate Number:	1953.01
FCC Accredited Test Site Designation No:	US1060
Industry Canada Test Site Registration No:	4294A
NCC CAB Identification No:	US0177

Environmental conditions varied slightly throughout the tests:

Relative humidity of 28 ± 4%
Temperature of 22 ± 3° C

2.3 EUT Setup

EUT was powered by 4 AA batteries. EUT was paired with an NFC Card for testing

3 Test Results

3.1 Radiated Emissions, Field Strength and Band edge

Test:	FCC Part 15.225 (a), (b), (c), (d)
Test Specifications:	Class A
Test Result:	Complies

3.1.1 Test Description

Radiated emissions measurements were made from 30MHz to 1GHz at a distance of 3m (Radiated Emissions) and 3m (Bandwidth, Field Strength and Band edges) inside a semi-anechoic chamber. The EUT was rotated 360°, the antenna height varied from 1-4 meters and both the vertical and horizontal antenna polarizations examined. For measurements below 30 MHz, the loop antenna was used to measure in all 3 axes. The results were compared against the limits. Measurements were made by first using a spectrum analyzer to acquire the signal spectrum; individual frequencies were then measured using a CISPR 16.1 compliant receiver with the following bandwidth setting:

30MHz – 1GHz: 120kHz IF bandwidth, 60kHz steps
150kHz – 30MHz: 9kHz RBW, 4.5 kHz steps

Intermodulation products were investigated by measuring spurious emissions with each of the two 2.4 GHz radios running in parallel with the NFC radio. No intermodulation products were found above the labs system sensitivity.

3.1.2 Test Results

No radiated emissions measurements were found in excess of the limits. Test result data can be seen below.

3.1.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility in the 10m semi-anechoic chamber. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 30 ± 5%
Temperature of 23 ±2^{o} C

3.1.4 Test Setup

See Section 2.3 for further details.

3.1.5 Test Equipment Used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	July 17, 2023	July 17, 2025
Com-Power Hybrid Antenna	ACL-6000	10350002	April 29, 2024	April 29, 2025
Com-Power Active Loop Antenna	Al-130R	10160084	July 24, 2023	July 23, 2024
Agilent Preamp*	87405A	3207A01475	May 2, 2024	May 2, 2026
ETS – Lindgren- VSWR on 10m Chamber	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	May 15, 2024	May 15, 2027
NCEE Labs-NSA on 10m Chamber*	10m Semi-anechoic chamber-NSA	NCEE-001	May 22, 2024	May 22, 2026
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	June 5, 2023	June 5, 2025
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3874	June 5, 2023	June 5, 2025
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	June 5, 2023	June 5, 2025
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	June 5, 2023	June 5, 2025
N connector bulkhead (control room)*	PE9128	NCEEBH2	June 5, 2023	June 5, 2025
TDK Emissions Lab Software	V11.25	700307	NA	NA

*Internal Characterization

3.1.6 Test Pictures and/or Figures

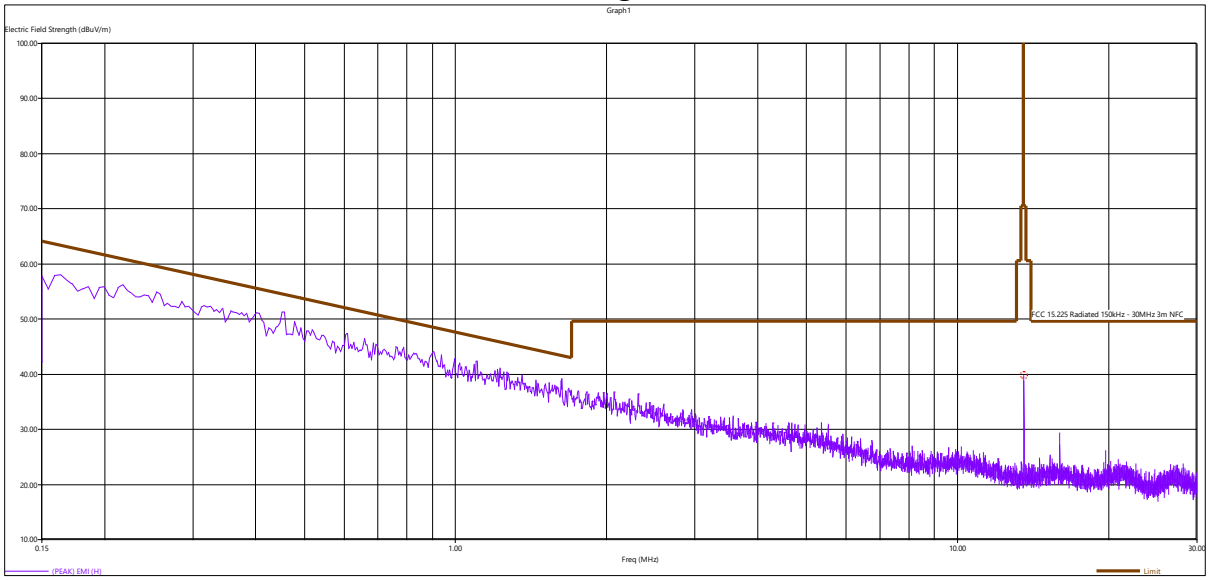

Figure 1 – NFC Radiated Emissions Plot, 10MHz – 30MHz

The loop antenna was maximized in all 3 orthogonal axes. The worst-case is shown in the plot and table above. All other emissions were found to be at least 6dB below the limit line.

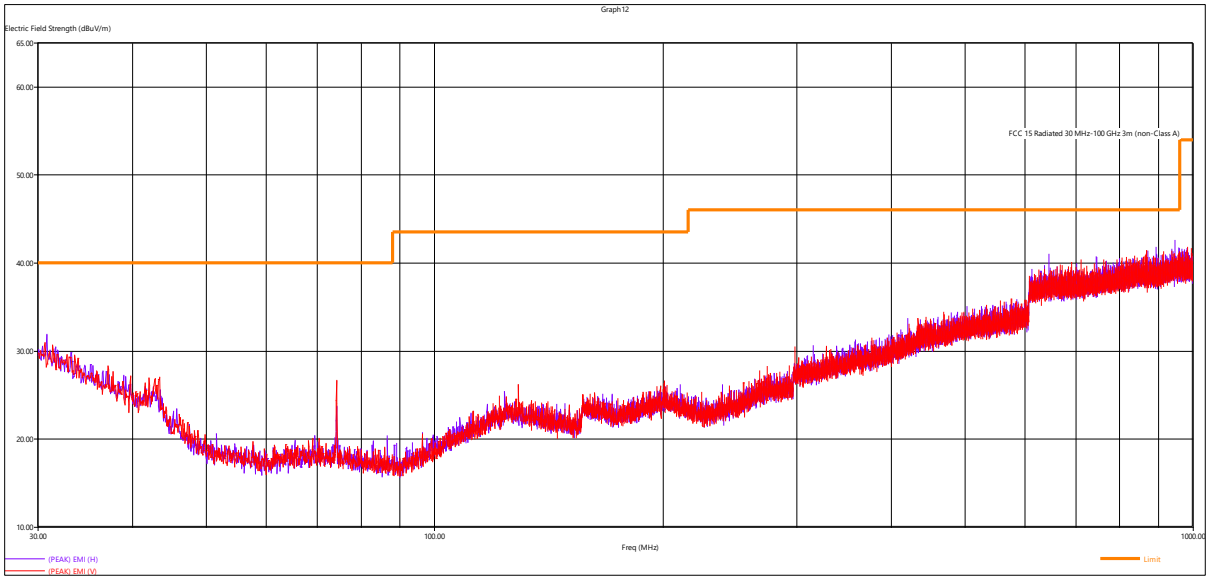

Figure 2 – NFC Radiated Emissions Plot, 30MHz – 1GHz

All emissions found to be at least 6dB below limit line

All other emissions were found to be at least 6dB below the limit line. System Noise floor was at least 6 dB below the limit line throughout the test range.

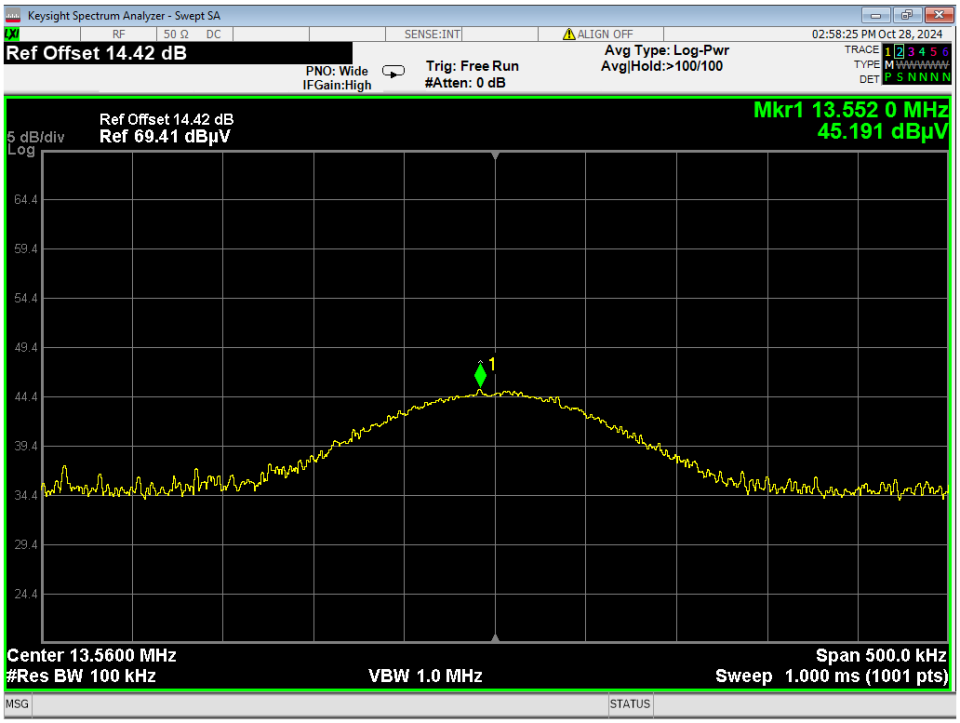

Figure 3 –Fundamental Field Strength Plot

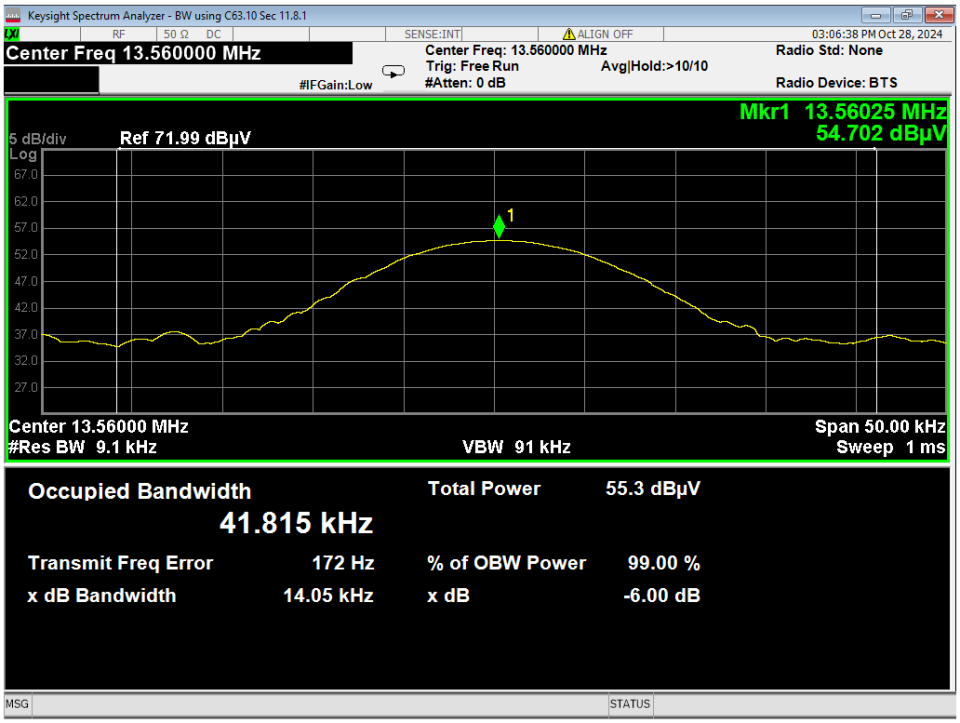

Figure 4 – Occupied Bandwidth

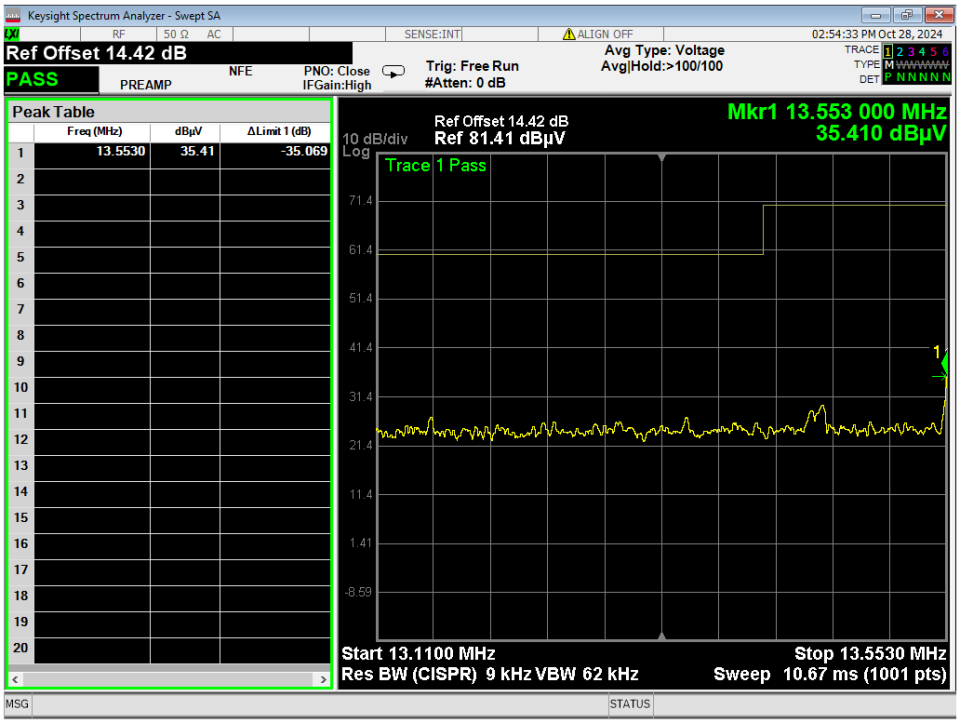

Figure 5 – Lower Band Edge

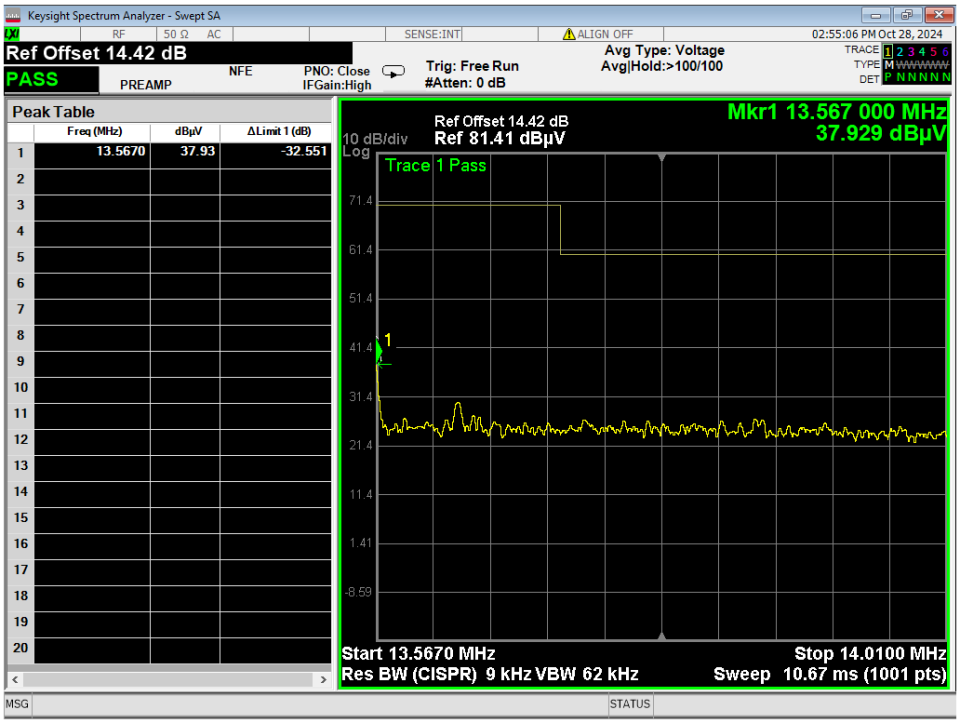

Figure 6 – Higher Band Edge

All band edge emissions were found to be at least 10dB below the applicable limit line and were not tabulated

3.1 Frequency Error

Test:	FCC Part 15.225 (e)
Test Result:	Complies

3.1.1 Test Description

Frequency error was determined using the built-in frequency error function of the spectrum analyzer. The analyzer finds the occupied bandwidth, calculates the center of the given band then returns the deviation with respect to the given transmit frequency. The temperature was varied from -20°C to 50°C. The voltage was not variable, but the battery was let to drain, voltage of drained battery was reported.
Limit: 100 PPM

3.1.2 Test Results

No results were found to be in excess of the limits. A table of the results can be seen below.

3.1.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility.
Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 30 ± 5%
Temperature of 23 ±2^{o} C

3.1.4 Test Setup

Device was tested with fresh batteries for testing.
See Section 2.3 for further details.

3.1.5 Test Equipment Used

See section 2.4 for the equipment list.

3.1.6 Test results

KIC Select series locks	
Temperature (°C)	**Channel (Hz)**
	13.56000 Nom.
-20°C	+428
-10°C	+400
0°C	+371
10°C	+335
20°C	+313
30°C	+300
40°C	+277
50°C	+262

*Tests were performed on brand new batteries

Limit: 100 PPM = 0.01% = 0.01 x 13.56 MHz = 1356 Hz
Values shown in Hz.
Uncertainty = ±500 Hz

APPENDIX A: SAMPLE CALCULATION

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor, Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain
AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]^2 / 30
Power (watts) = 10^[Power (dBm)/10] / 1000
Voltage (dBμV) = Power (dBm) + 107 (for 50Ω measurement systems)
Field Strength (V/m) = 10^[Field Strength (dBμV/m) / 20] / 10^6
Gain = 1 (numeric gain for isotropic radiator)
Conversion from 3m field strength to EIRP (d=3):

EIRP = [FS(V/m) x d^2]/30 = FS [0.3] for d = 3

EIRP(dBm) = FS(dBμV/m) – 10(log 10^9)+ 10log[0.3] = FS(dBμV/m) - 95.23
10log(10^9) is the conversion from micro to milli

APPENDIX B – MEASUREMENT UNCERTAINTY

NCEE Does not add uncertainty to measurements.
Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08

Expanded uncertainty values are calculated to a confidence level of 95%.

REPORT END