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Report on the Radio Testing of:

CELL ANALYSIS SYSTEM

Model(s): V1

In accordance with
47 CFR FCC Part 15C

Prepared for:
Cellanome, Inc.
1810 Embarcadero Road,
Suite 200, Palo Alto,
CA 94303 USA

COMMERCIAL-IN-CONFIDENCE

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RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Approved By	Foo Kai Maun	23 Sep 2024	
Prepared By	Quek Keng Huat	23 Sep 2024	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD PSB document controlrules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with the mentioned standard(s).

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Contents

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	18 Apr 2024
2	2nd Issue – update applicant info	23 Sep 2024

1.2 Introduction

Applicant	:	Cellanome, Inc. 1810 Embarcadero Road, Suite 200, Palo Alto, CA 94303 USA
Manufacturer	:	Same as applicant
Factory	:	Refer to manufacturer
Model Number(s)	:	V1
Serial Number(s)	:	CEL-N3-5863
Number of Samples Tested	:	1
Test Sample(s) Condition	:	Good
Quotation Reference	:	5892745
Test Specification/Issue/Date	:	FCC 47 CFR Part 15C
Test Sample(s) Received Date	:	01 Feb 2024
Start of Test	:	01 Feb 2024
Finish of Test	:	06 Mar 2024

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with specifications as shown below.

Specification Clause	Test Description	Result	Comments/Base Standard
47 CFR FCC Part 15			
15.107(a), 15.207	Conducted Emissions	Pass	ANSI C63.4: 2014 ANSI C63.10: 2013
15.109(a), 15.205, 15.209, 15.225(d)	Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)	Pass	ANSI C63.4: 2014 ANSI C63.10: 2013
15.225(a)	Radiated Emissions (Fundamental)	Pass	ANSI C63.10: 2013
15.225(b)	Radiated Emissions (Fundamental)	Not Applicable *See Note 3	ANSI C63.10: 2013
15.225(c)	Radiated Emissions (Fundamental)	Not Applicable *See Note 3	ANSI C63.10: 2013
15.225(e)	Frequency Stability Versus Temperature	Pass	ANSI C63.10: 2013
15.225(e)	Frequency Stability Versus Input Voltage	Pass	ANSI C63.10: 2013

Notes

1. The measurements in section 15.235(e) were done based on conducted measurements.
2. The EUT is a Class B device when in non-transmitting state and meets the 47 CFR FCC Part15B Class B requirements.
3. The EUT's carrier is in 13.553 -13.567MHz.
4. The EUT was operated in continuous transmission, ie 100% duty cycle.
5. Cellanome, Inc. declares that the RFID module used for Chiller detect function and Flow Cell detect function are electrically identical. The only difference is the cable length to the antenna PCB. The Chiller RFID antenna cable is 30cm in length, while the Flow Cell RFID antenna cable is 80cm in length.

1.4 Product Information

1.4.1 Technical Description

Description	:	The Equipment Under Test(s) (EUT(s)) is a **CELL ANALYSIS SYSTEM** for single-cell multi-omics analysis at scale, which enables flexible exploration of cellular phenotype, function, behaviour, and underlying omics.
Microprocessor	:	ESP32 PICO V3 (on Pepper C1 v2.x) ESP32-D0WDQ6-V3 (on Pepper C1 v1.x)
Operating Frequency	:	240MHz (MCU operating frequency)
Clock / Oscillator Frequency	:	13.56MHz (RFID chip external oscillator)
Modulation	:	Amplitude Shift Keying (ASK)
Antenna Gain	:	0dBi
Port / Connectors	:	1 x AC Inlet 2 x USB A 1 x LAN port
Rated Power	:	Input 100V–240V 50Hz–60Hz 15A
Accessories	:	Nil

1.4.2 Test Configuration and Modes of Operation

Mode(s)	Description
Maximum RF power transmission	The EUT was exercised in the mode, transmitting at 13.56MHz with all supported modulation schemes was evaluated.

1.4.3 Performance Criteria and Monitoring Methods

Not Applicable.

1.5 Deviations from the Standard

Nil.

1.6 EUT Modification Record

No modifications were made.

1.7 Test Location(s)

TÜV SÜD PSB Pte Ltd
Electrical & Electronics Centre (EEC), Product Services,
15 International Business Park
TÜV SÜD @ IBP
Singapore 609937

1.8 Test Facilities Registrations

Requirements	Registration Numbers
FCC	994109 (Test Firm Registration Number) SG0002 (Designation Number)
ISED	SGAP01 (CAB Identifier) 2932I (10m Semi-Anechoic Chamber)
VCCI	R-13324 (10m ANC), G-10203 (10mANC) R-20151 (3m RF Chamber - Lab 7), G-20149 (3m RF Chamber - Lab 7) C-14933 (C.E @ CEIBP) T-12403 (Telecom Ports @ CEIBP)
BSMI	SL2-IS-E-6001R *[CNS-13803 (ISM Equipment)]* SL2-IN-E-6001R *[CNS-13438, CNS-15936 (IT Equipment)]* SL2-R1/R2-E-6001R *[CNS-13439, CNS-15936 (Broadcast Receivers)]* SL2-A1-E-6001R *[CNS-13783-1 (Household Appliances)]* SL2-L1-E-6001R *[CNS-14115 (Lighting Equipment)]*
SABS	SABS/A-LAB/0030/2018
ASCA	TL-86

1.9 Supporting Equipment

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
Dlink Wireless AC1750 Dual-Band Gigabit Cloud Router	M/N: DIR-868L S/N: RZGE1F9013157 FCC ID: KA2IR868LA1	
Asian Power Devices Inc. AC Adapter	M/N: WA-36A12 S/N: 349159833-BAB FCC ID: SDoC	1.50 m unshielded power cable

2 Test Details

2.1 Conducted Emissions

2.1.1 Test Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (Q-P)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

2.1.2 Test Setup

2.1.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.

2.1.2.2 The power supply for the EUT was fed through a 50Ω/50µH EUT LISN, connected to filtered mains.

2.1.2.3 The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.

2.1.2.4 All other supporting equipment were powered separately from another LISN.

2.1.3 Test Method

2.1.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.

2.1.3.2 A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.

2.1.3.3 High peaks, relative to the limit line, were then selected.

2.1.3.4 The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 9kHz. Both Quasi-peak and Average measurements were made.

2.1.3.5 The measurements were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz	Q-P limit = 60.0 dBµV
Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB	
Q-P reading obtained directly from EMI Receiver = 40.0 dBµV (Calibrated for system losses)	
Therefore, Q-P margin = 60.0 - 40.0 = 20.0	i.e. 20.0 dB below Q-P limit

2.1.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Line Under Test	AC Mains	Relative Humidity	51%
RFID	Flowcell RFID	Atmospheric Pressure	1029mbar
		Tested By	Nazrulhizat / Asyrul
		Test Date	06 Feb 2024

Frequency (MHz)	Q-P Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line
0.1678	47.7	79.0	31.3	47.6	66.0	18.4	Live
0.2519	55.3	79.0	23.7	54.7	66.0	11.3	Live
0.3356	48.4	79.0	30.6	48.1	66.0	17.9	Neutral
0.4196	58.5	79.0	20.5	58.3	66.0	7.7	Neutral
0.5036	49.0	73.0	24.0	48.6	60.0	11.4	Neutral
18.7492	34.3	73.0	38.7	28.7	60.0	31.3	Live

Test Input Power	120V 60Hz	Temperature	24°C
Line Under Test	AC Mains	Relative Humidity	51%
RFID	Chiller RFID	Atmospheric Pressure	1029mbar
		Tested By	Nazrulhizat / Asyrul
		Test Date	06 Feb 2024

Frequency (MHz)	Q-P Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line
0.1677	49.2	79.0	29.8	49.2	66.0	16.8	Neutral
0.1900	40.1	79.0	38.9	34.9	66.0	31.1	Neutral
0.2518	56.5	79.0	22.5	56.2	66.0	9.8	Neutral
0.4196	56.0	79.0	23.0	55.9	66.0	10.1	Live
0.5034	49.3	73.0	23.7	49.0	60.0	11.0	Live
6.4432	35.4	73.0	37.6	28.6	60.0	31.4	Live

Notes

1.	All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2.	A "positive margin" indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative margin" indicates a FAIL.
3.	*EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:* 150kHz - 30MHz RBW: 9kHz VBW: 30kHz

2.2 Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)

2.2.1 Test Limits

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m)
0.009 - 0.490 *	20 log [2400 / F (kHz)] @ 300m
0.490 - 1.705	20 log [24000 / F (kHz)] @ 30m
1.705 - 30.0	30.0 @ 30m
30 – 88	40.0 @ 3m
88 – 216	43.5 @ 3m
216 – 960	46.0 @ 3m
Above 960 *	54.0 @ 3m
* For frequency bands 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

Restricted Bands

MHz			MHz			MHz			GHz		
0.090	-	0.110	16.42	-	16.423	399.9	-	410	4.5	-	5.15
0.495	-	0.505	16.69475	-	16.69525	608	-	614	5.35	-	5.46
2.1735	-	2.1905	16.80425	-	16.80475	960	-	1240	7.25	-	7.75
4.125	-	4.128	25.5	-	25.67	1300	-	1427	8.025	-	8.5
4.17725	-	4.17775	37.5	-	38.25	1435	-	1626.5	9.0	-	9.2
4.20725	-	4.20775	73	-	74.6	1645.5	-	1646.5	9.3	-	9.5
6.215	-	6.218	74.8	-	75.2	1660	-	1710	10.6	-	12.7
6.26775	-	6.26825	108	-	121.94	1718.8	-	1722.2	13.25	-	13.4
6.31175	-	6.31225	123	-	138	2200	-	2300	14.47	-	14.5
8.291	-	8.294	149.9	-	150.05	2310	-	2390	15.35	-	16.2
8.362	-	8.366	156.52475	-	156.52525	2483.5	-	2500	17.7	-	21.4
8.37625	-	8.38675	156.7	-	156.9	2690	-	2900	22.01	-	23.12
8.41425	-	8.41475	162.0125	-	167.17	3260	-	3267	23.6	-	24.0
12.29	-	12.293	167.72	-	173.2	3332	-	3339	31.2	-	31.8
12.51975	-	12.52025	240	-	285	3345.8	-	3358	36.43	-	36.5
12.57675	-	12.57725	322	-	335.4	3600	-	4400	Above 38.6		
13.36	-	13.41									

2.2.2 Test Setup

2.2.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.

2.2.2.2 The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.

2.2.2.3 The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

2.2.3 Test Method

2.2.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.

2.2.3.2 A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.

2.2.3.3 The test was carried out at the selected frequency points obtained from the pre-scan. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:

a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
b. The EUT was then rotated to the direction that gave the maximum emission.
c. Finally, the antenna height was adjusted to the height that gave the maximum emission.

2.2.3.4 A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz.For frequency point in range of 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, both Peak and Average measurements were carried out.

2.2.3.5 The measurements were repeated for the next frequency point, until all selected frequency points were measured.

2.2.3.6 The frequency range covered was from the lowest radio frequency signal generated from the EUT, without going below 9kHz to 10th harmonics of the EUT fundamental frequency, using the loop antenna for frequency below 30MHz, Bi-log antenna for frequencies from 30MHz up to 1GHz, and the Horn antenna above 1GHz.

Sample Calculation Example

At 300 MHz	Q-P limit = 46.0 dBμV/m
Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m (Calibrated level including antenna factors & cable losses)	
Therefore, Q-P margin = 46.0 - 40.0 = 6.0	i.e. 6.0 dB below Q-P limit

2.2.5 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Test Distance	3m (<30MHz) 3m (30MHz – 1GHz)	Relative Humidity	60%
RFID	Flowcell RFID	Atmospheric Pressure	1030mbar
		Tested By	Anthony Toh
		Test Date	02 Feb 2024 & 16 Feb 2024

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Note 6 & 7

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 4	AV Limit (dBµV/m *See Note 5	AV Margin (dB)	Height (cm)	Azimuth (Degrees)
0.1350	63.2	139.4	76.2	--	119.4	56.2	120	344
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Spurious Emissions ranging from 9kHz – 30MHz *See Note 6

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
8.1660	28.6	70.0	41.4	120	5
12.4650	24.5	70.0	45.5	120	9
18.7650	26.8	70.0	43.2	120	319
21.6280	33.4	70.0	36.6	120	341
28.9820	26.2	70.0	43.8	120	15
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Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
54.2320	30.0	40.0	10.0	100	351	V
68.8630	32.9	40.0	7.1	100	307	V
208.8990	31.4	43.5	12.1	100	307	V
360.1370	32.9	46.0	13.1	200	137	V
595.2400	33.8	46.0	12.2	399	340	H
617.1860	34.3	46.0	11.7	100	18	H

Test Input Power	120V 60Hz	Temperature	24°C
Test Distance	3m (<30MHz) 3m (≥30MHz – 1GHz)	Relative Humidity	60%
RFID	Chiller RFID	Atmospheric Pressure	1030mbar
		Tested By	Anthony Toh
		Test Date	02 Feb 2024 & 16 Feb 2024

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Note 6 & 7

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 4	AV Limit (dBµV/m *See Note 5	AV Margin (dB)	Height (cm)	Azimuth (Degrees)
0.1350	63.7	139.4	75.7	--	119.4	55.7	120	336
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Spurious Emissions ranging from 9kHz – 30MHz *See Note 6

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
3.3580	30.7	68.3	37.6	120	349
8.3290	29.4	70.0	40.6	120	14
21.6860	35.8	70.0	34.2	120	18
27.0370	23.1	70.0	46.9	120	340
28.8930	27.7	70.0	42.3	120	18
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Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
68.3080	33.9	40.0	6.1	100	331	V
100.5410	29.7	43.5	13.8	200	5	H
124.5770	27.5	43.5	16.0	100	87	V
210.4340	33.3	43.5	10.2	100	225	V
324.1160	27.2	46.0	18.8	100	320	V
359.9410	32.8	46.0	13.2	200	137	V

Notes

1.	All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2.	A "positive margin" indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative margin" indicates a FAIL.
3.	*EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:* 9kHz – 150kHz RBW: 200Hz VBW: 1kHz 150kHz – 30MHz RBW: 9kHz VBW: 30kHz 30MHz - 1GHz RBW: 120kHz VBW: 1MHz >1GHz RBW: 1MHz VBW: 3MHz
4.	As the measured peak shows compliance to the average limit, as such no average measurement was required.
5.	The average margin indicates the margin of the measured peak value below the average limit.
6.	"–" indicates no emissions were found and shows compliance to the limits
7.	The measurement was done at 3m. The measured results were extrapolated to the specified test limits as specified in § 15.209 (a) based on 40dB/decade.
8.	Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz. The average measurement was done by averaging over a complete cycle of the pulse train, including the blanking interval as the pulse train duration does not exceed 0.1 second.
9.	The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33 (a) for intentional radiators & Section 15.33 (b) for unintentional radiators.
10.	The channel in the table refers to the transmit channel of the EUT.

2.3 Radiated Emissions (Fundamental)

2.3.1 Test Limits

Fundamental Frequency (MHz)	Field Strength of Fundamental Limit Values @ 30m (dBµV/m)
13.553 - 13.567	84.0
13.410 -13.553	50.5
13.567 -13.710	50.5
13.110 -13.410	40.5
13.710 -14.010	40.5

2.3.2 Test Setup

2.3.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.

2.3.2.2 The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.

2.3.2.3 The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

2.3.3 Test Method

2.3.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.

2.3.3.2 A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.

2.3.3.3 The test was carried out at the selected frequency points obtained from the pre-scan. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:

a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
b. The EUT was then rotated to the direction that gave the maximum emission.
c. Finally, the antenna height was adjusted to the height that gave the maximum emission.

2.3.3.4 A Quasi-peak measurement was made for that frequency point using the loop antenna.

2.3.3.5 The measurements were repeated for the next frequency point, until all selected frequency points were measured.

Sample Calculation Example

At 300 MHz Q-P limit = 46.0 dBµV/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB
Q-P reading obtained directly from EMI Receiver = 40.0 dBµV/m
(Calibrated level including antenna factors & cable losses)

Therefore, Q-P margin = 46.0 - 40.0 = 6.0 i.e. 6.0 dB below Q-P limit

2.3.4 Test Results

Test Input Power	120V 60Hz	Temperature	27°C
Test Distance	10m *see Note 4	Relative Humidity	55%
RFID	Flowcell RFID	Atmospheric Pressure	1020mbar
		Tested By	Anthony Toh
		Test Date	16 Feb 2024

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
13.5590	40.3	84.0	43.7	120	352

Test Input Power	120V 60Hz	Temperature	27°C
Test Distance	10m *see Note 4	Relative Humidity	55%
RFID	Chiller RFID	Atmospheric Pressure	1020mbar
		Tested By	Anthony Toh
		Test Date	16 Feb 2024

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
13.5590	45.3	84.0	38.7	120	25

Notes

1.	All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2.	A "positive margin" indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative margin" indicates a FAIL.
3.	EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings: 9kHz – 150kHz RBW: 200Hz VBW: 1kHz 150kHz – 30MHz RBW: 9kHz VBW: 30kHz 30MHz - 1GHz RBW: 120kHz VBW: 1MHz >1GHz RBW: 1MHz VBW: 3MHz
4.	A closer test distance of 10m was used for the measurement instead of 30m as the fundamental (carrier) electric field strength of the EUT at the 10m distance shows compliance to the limit of 30m test distance.

2.4 Frequency Stability Versus Temperature

2.4.1 Test Limits

The EUT shows compliance to the requirements of this section, which states that the frequency tolerance of the carrier frequency shall be ± 0.01% for a temperature variation of -20°C to +50°C at normal supply voltage.

2.4.2 Test Setup

2.4.2.1 The EUT and supporting equipment were set up as shown in the setup photo. The EUT was placed in an environmental temperature chamber with a nominal supply voltage. For the battery operated EUT, a new battery was used.

2.4.2.2 The RF antenna connector of the EUT was connected to the frequency counter via a low-loss coaxial cable.

2.4.3 Test Method

2.4.3.1 The EUT was switched off and the environmental temperature was set to the highest temperature, i.e, +50°C.

2.4.3.2 Upon reaching the highest set temperature with 30 minutes of stabilisation period, the EUT was switched on and configured to operate in the test mode with transmitting frequency at 13.56MHz.

2.4.3.3 The EUT's transmitting frequency was then measured at start up, and two, five and ten minutes after start up with the frequency counter to capture the transmitting frequency. For each measurement, the signal capturing was continuous until no further changes were observed. Four measurements were made in total.

2.4.3.4 The EUT was switched off. The environmental chamber temperature was lowered by 10°C and was allowed the temperature inside the chamber to stabilize.

2.4.3.5 The EUT was turned on and the measurements were repeated until the lowest temperature was reached, i.e, -20°C.

2.4.5 Test Results

Test Input Power	120V 60Hz	Temperature	Please See Below
RFID (Worst)	Chiller RFID	Relative Humidity	55%
		Atmospheric Pressure	1020mbar
		Tested By	Anthony Toh
		Test Date	21 Feb 2024

Channel Frequency (MHz)	Temperature (°C)	Measured Carrier Frequency (MHz)	Carrier Frequency Variation (%)	Tolerance (%)	Measurement with respects to Start Up Time (Mins)
13.5600	50.0	13.56007986	-0.001	± 0.01	0
		13.56007585	-0.001	± 0.01	2
		13.56007399	-0.001	± 0.01	5
		13.56007300	-0.001	± 0.01	10
	40.0	13.56010724	-0.001	± 0.01	0
		13.56009545	-0.001	± 0.01	2
		13.56009263	-0.001	± 0.01	5
		13.56008920	-0.001	± 0.01	10
	30.0	13.56013216	-0.001	± 0.01	0
		13.56013021	-0.001	± 0.01	2
		13.56012937	-0.001	± 0.01	5
		13.56011639	-0.001	± 0.01	10
	20.0	13.56014474	-0.001	± 0.01	0
		13.56014602	-0.001	± 0.01	2
		13.56014631	-0.001	± 0.01	5
		13.56014489	-0.001	± 0.01	10
	10.0	13.56017120	-0.001	± 0.01	0
		13.56017500	-0.001	± 0.01	2
		13.56017919	-0.001	± 0.01	5
		13.56018114	-0.001	± 0.01	10
	0.0	13.56020003	-0.001	± 0.01	0
		13.56020353	-0.002	± 0.01	2
		13.56020329	-0.001	± 0.01	5
		13.56020340	-0.002	± 0.01	10
	-10.0	13.56021323	-0.002	± 0.01	0
		13.56021384	-0.002	± 0.01	2
		13.56021416	-0.002	± 0.01	5
		13.56021436	-0.002	± 0.01	10
	-20.0	13.56021056	-0.002	± 0.01	0
		13.56021033	-0.002	± 0.01	2
		13.56021077	-0.002	± 0.01	5
		13.56020945	-0.002	± 0.01	10

Notes

1.	Only Chiller RFID was measured and reported as the difference between Chiller and Flow Cell RFID is the cable length to the antenna PCB. The Chiller RFID antenna cable is 30cm in length, while the Flow Cell RFID antenna cable is 80cm in length.

2.5 Frequency Stability Versus Input Voltage

2.5.1 Test Limits

The EUT shows compliance to the requirements of this section, which states that the frequency tolerance of the carrier frequency shall be ± 0.01% for variation of a primary voltage from 85% to 115% of the rated supply voltage at a temperature of 20°C. For a battery operated equipment, the equipment tests shall be performed using a new battery.

2.5.2 Test Setup

2.5.2.1 The EUT and supporting equipment were set up as shown in the setup photo. The EUT was placed in an environmental temperature chamber with a nominal supply voltage. For the battery operated EUT, a new battery was used.

2.5.2.2 The RF antenna connector of the EUT was connected to the frequency counter via a low-loss coaxial cable.

2.5.3 Test Method

2.5.3.1 The EUT was switched off and the environmental temperature was set to 20°C.

2.5.3.2 Upon reaching the set temperature with 30 minutes of stabilisation period, the EUT was switched on and configured to operate in the test mode with transmitting frequency at 13.56MHz.

2.5.3.3 The EUT's transmitting frequency was then measured with the frequency counter to capture the transmitting frequency. The signal capturing was continuous until no further changes were observed. Four measurements were made in total.

2.5.3.4 The measurements were repeated with the supply voltage set to 85% and 115% of the nominal voltage supply respectively.

2.5.5 Test Results

Test Input Power	120V 60Hz	Temperature	27°C
RFID (Worst)	Chiller RFID	Relative Humidity	55%
		Atmospheric Pressure	1020mbar
		Tested By	Anthony Toh
		Test Date	21 Feb 2024

Channel Frequency (MHz)	Test Input Power (Vdc)	Measured Carrier Frequency (MHz)	Carrier Frequency Variation (%)	Tolerance (%)
13.5600	5.00	13.5601189776	-0.001	± 0.01
	4.25	13.5601132933	-0.001	± 0.01
	5.75	13.5601243711	-0.001	± 0.01

Notes

1.	Only Chiller RFID was measured and reported as the difference between Chiller and Flow Cell RFID is the cable length to the antenna PCB. The Chiller RFID antenna cable is 30cm in length, while the Flow Cell RFID antenna cable is 80cm in length.

2.6 Occupied Bandwidth (99% Bandwidth Measurement)

2.6.1 Test Limits

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

2.6.2 Test Setup

2.6.2.1 The EUT and supporting equipment were set up as shown in the set up photo.

2.6.2.2 The power supply for the EUT was connected to a filtered mains.

2.6.2.3 The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

2.6.2.4 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 1kHz and 3 times of RBW.

2.6.2.5 All other supporting equipment were powered separately from another filtered mains.

2.6.3 Test Method

2.6.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at lower channel.

2.6.3.2 The center frequency of the spectrum analyser was set to the transmitting frequency with the frequency span wide enough to capture the 6dB bandwidth of the transmitting frequency.

2.6.3.3 The spectrum analyser was set to max hold to capture the transmitting frequency. The signal capturing was continuous until no further changes were observed.

2.6.3.4 The peak of the transmitting frequency was detected with the marker peak function of the spectrum analyser. The 99% bandwidth measurement in the spectrum analyser power measurement was activated.

2.6.3.5 The measured 99% bandwidth shown on the spectrum analyser was recorded.

2.6.4 Test Results

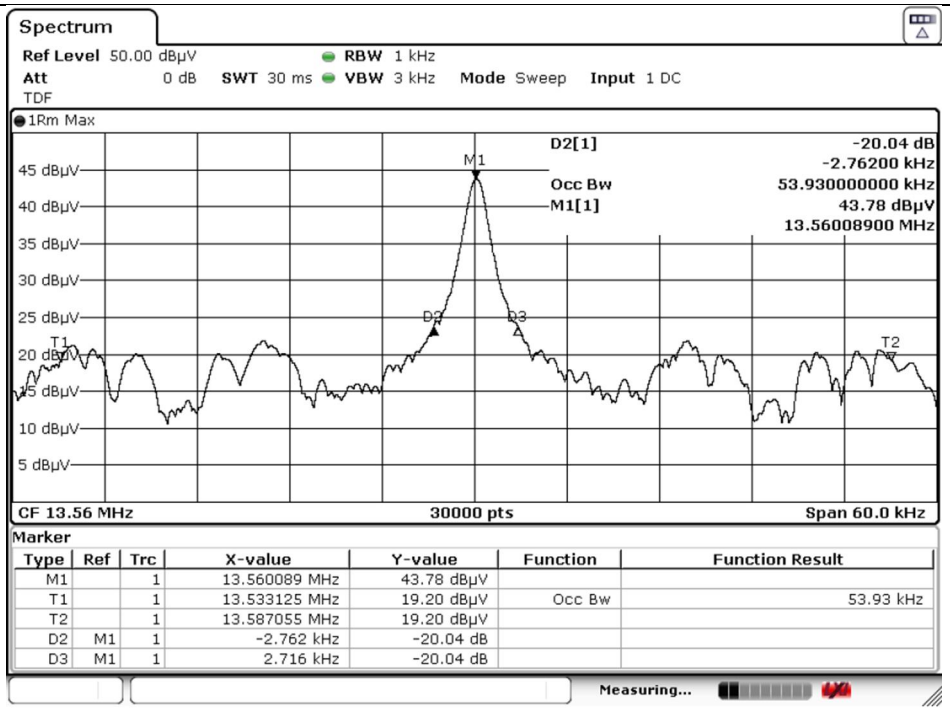
Test Input Power	120V 60Hz	Temperature	27°C
Attached Plots	1 – 2	Relative Humidity	55%
		Atmospheric Pressure	1020mbar
		Tested By	Anthony Toh
		Test Date	16 Feb 2024

RFID	Channel Frequency (MHz)	99% Bandwidth (kHz) *See Note 1
Chiller RFID	13.5600	53.930
Flowcell RFID	13.5600	54.118

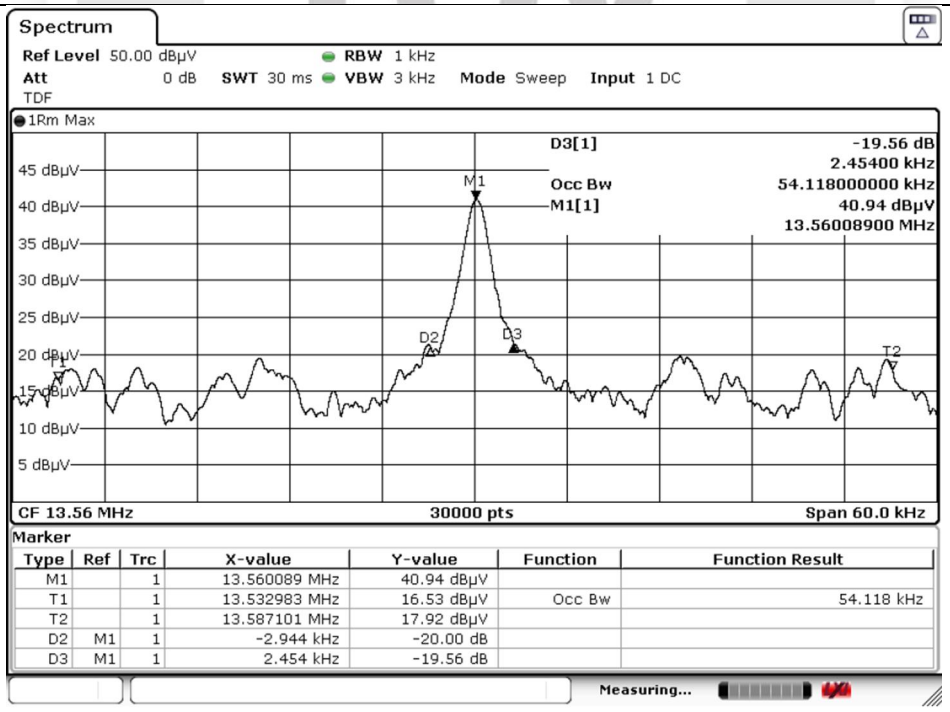
Notes

1.	Only the largest measured bandwidths were reported. Refer to plots for all measured bandwidth.

Spectrum Bandwidth (99% Bandwidth Measurement) Plots



Plot 1 – Chiller RFID



Plot 2 – FlowCell RFID

2.7 Maximum Permissible Exposure (MPE)

2.7.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the MPE limits for general population / uncontrolled exposure are as shown below:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (min)
0.3 - 1.34	614	1.63	100 Note 2	30
1.34 - 30	824 / f	2.19 / f	180 / f^2 Note 2	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	-	-	f / 1500	30
1500 - 100000	-	-	1.0	30
Notes				
1. f = frequency in MHz				
2. Plane wave equivalent power density				

2.7.2 Test Setup

2.7.2.1 The EUT and supporting equipment were set up as shown on the setup photo.

2.7.2.2 The relevant field probe was positioned at least 20cm away from the EUT and supporting equipment boundary.

2.7.3 Test Method

2.7.3.1 . The EUT was switched on and allowed to warm up to its normal operating condition.

2.7.3.2 The test was first carried out at one of the positions / sides of the EUT.

2.7.3.3 Power density measurement (mW/cm^2) was made using the field meter set to the required averaging time.

2.7.3.4 Measurements were repeated for the next position and its associate EUT operating mode, until all possible positions and modes were measured.

Sample Calculation Example

At 2400 MHz, limit = 1.0 mW/cm^2
Power density reading obtained directly from field meter = 0.3 mW/cm^2 averaged over the required 30 minutes.
Therefore, margin = 0.3 – 1.0 = -0.7 mW/cm^2 i.e. 0.7 mW/cm^2 below limit

2.7.4 Test Results

3 Photographs

TEST SETUP

Conducted Emissions at Mains Test Setup (Front View)

Conducted Emissions at Mains Test Setup (Rear View)

TEST SETUP (9kHz – 30MHz)

Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement) Test Setup (Front View)
Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement) Test Setup (Rear View)

TEST SETUP (30MHz to 1GHz)

Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement) Test Setup (Front View)
Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement) Test Setup (Rear View)

TEST SETUP

Radiated Emissions (Fundamental) Test Setup (Front View)
Radiated Emissions (Fundamental) Test Setup (Front View)

TEST SETUP

Occupied Bandwidth (99% Bandwidth Measurement) Test Setup

TEST SETUP

Frequency Stability Versus Temperature Test Setup
Frequency Stability Versus Input Voltage Test Setup

TEST SETUP

Maximum Permissible Exposure (MPE) Test Setup

EUT PHOTOGRAPHS

View 1
View 2

EUT PHOTOGRAPHS

RFID Circuit (with Antenna)

EUT PHOTOGRAPHS

EUT PHOTOGRAPHS

RFID Circuit Bottom View

EUT PHOTOGRAPHS

EUT PHOTOGRAPHS

4 Test Equipment

Instrument	Model	S/No	Cal Due Date
Conducted Emissions			
R&S EMI Test Receiver (9kHz - 3GHz)	ESPI3	100349	09 Aug 2024
AFJ LISN	AFJ LT32C/10	32031929295	13 Jul 2024
Schaffner LISN	NNB42	04/10055	08 Aug 2024
Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement) and Radiated Emissions (Fundamental)			
R&S EMI Test Receiver (9kHz - 26.5GHz)	ESR26	101714	14 Sep 2024
ETS Lindgren Loop Antenna	6502	134413	03 Jul 2024
Sonoma Preamplifier (1MHz – 1GHz)	310	254719	21 Jul 2024
TDK Bilog Antenna (30MHz – 1GHz)	HLP-3003C	130237	24 Jan 2025
Frequency Stability Versus Temperature and Frequency Stability Versus Input Voltage			
HP Universal Counter	53132A	3736A06236	04 Jul 2024
Xantrex DC Power Supply	XHR 150-4	33778	24 Sep 2024
TABAI Climate Chamber	PSL-2G	3511427	12 Jul 2024
Maximum Permissible Exposure			
Wavecontrol EM Field Meter	SMP2	21SN1744	03 Nov 2024
Wavecontrol Isotropic EM Field Probe (300kHz – 18GHz)	WPF18	21WP090498	03 Nov 2024
Wavecontrol Probe (1MHz – 40GHz)	WPF40	22WP140286	21 Jun 2024

5 Measurement Uncertainty

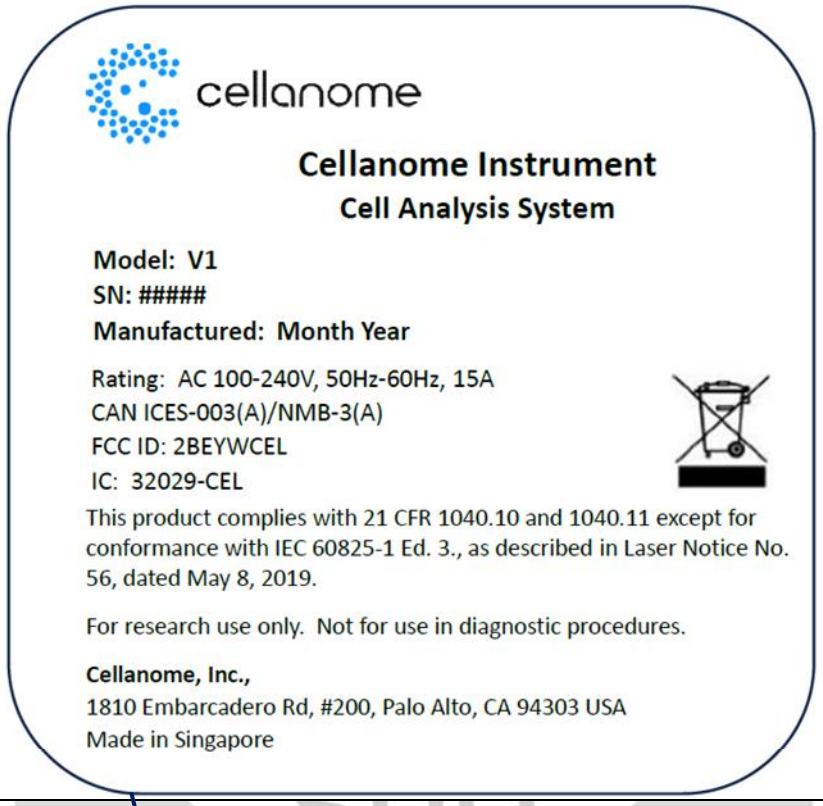
All measured results are traceable to the SI units. The uncertainty of the measurement is at a confidence level of approximately 95%, with a coverage factor of 2.

Test Name	Measurement Uncertainty
Conducted Emissions at Mains Terminals	1.1dB (9kHz to 30MHz)
Radiated Emissions	10m Anechoic Chamber (Lab 4) 2.2dB (9kHz to 30MHz @ 10m) 3.1dB (30MHz to 1GHz @ 10m) 3.7dB (30MHz to 1GHz @ 3m) 4.7dB (>1GHz to 40GHz @ 3m) 3m RF Chamber (Lab7) 3.6dB (30MHz to 1GHz @ 3m) 4.7dB (>1GHz to 40GHz @ 3m)

6 Annex A – FCC Label and Position

Labelling requirements per Section 2.925 & 15.19

The label shown will be permanently affixed at a conspicuous location on the device and be readily visible to the user at the time of purchase.



Sample Label

Physical Location of FCC Label on EUT

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Effective 26 January 2021

End of the Test Report