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EMC-EMF Safety Approvals

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## EMI TEST REPORT for CERTIFICATION of FCC PART 15.225 & FCC PART 15.207 TRANSMITTER

**FCC ID:** 2ACXQ-PSC-6040  
**Manufacturer:** Sato Vicinity Pty Ltd  
**Test Sample:** RFID Smart Cabinet  
**Model:** PSC-6040  
**Serial No:** Production Prototype

**Date:** 14<sup>th</sup> April 2016

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Accreditation No. 5292

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**EMI TEST REPORT FOR CERTIFICATION  
FOR  
CERTIFICATION OF FCC Part 15.225 & FCC PART 15.207 TRANSMITTER**

**FCC ID: 2ACXQ-PSC-6040  
EMC Technologies Report No. T160221\_F  
Date: 5<sup>th</sup> April 2016**

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**EMI TEST REPORT FOR CERTIFICATION  
OF  
FCC PART 15.225 & FCC PART 15.207 TRANSMITTER**

**Report Number:** T160221\_F  
**Test Sample Name:** RFID Smart Cabinet  
**Model Number:** PSC-6040  
**Serial Number:** Production Prototype  
**FCC ID:** 2ACXQ-PSC-6040  
**Manufacturer:** Sato Vicinity Pty Ltd  
**Tested For:** Sato Vicinity Pty Ltd  
**Address:** 8 Guihen Street  
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Australia  
**Phone:** +61 2 9562 9800  
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**Responsible Party:** Tai Wai Pong  
**Test Standards:** **FCC Part 15.225 Intentional Radiators**  
**FCC Part 15.207 Conducted Limits**  
**ANSI C63.4:2003**  
**OET Bulletin No. 65**  
**Test Dates:** 16<sup>th</sup> March 2016 to 24<sup>th</sup> March 2016

**Testing Officer:**



Robert Middleton

**Attestation:**

*I hereby certify that the device(s) described herein were tested as described in this report and that the data included is that which was obtained during such testing.*

**Authorised Signature:**



Christian Kai  
Facility Manager  
**EMC Technologies Pty Ltd**

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**EMI TEST REPORT FOR CERTIFICATION**  
**of**  
**FCC PART 15.225 & FCC PART 15.207 TRANSMITTER**  
**on the RFID Smart Cabinet**

## 1.0 SUMMARY of RESULTS

This report details the results of EMI tests and measurements performed on the RFID Smart Cabinet, Model: PSC-6040, in accordance with the Federal Communications Commission (FCC) regulations as detailed in Title 47 CFR, Part 15 Rules for intentional radiators. Some auxiliary functions of the cabinet, not relating to the transmitter circuit have been switched off during the testing. All results are detailed in this report.

**Part 15.31e**

Amplitude stability with supply variation: Complied

**Part 15.207**

Conducted Emissions: Complied

**Part 15.225 a, b & c**

Carrier Signal Field Strength 13.110 – 14.010MHz: Complied

**Part 15.225 d (15.209)**

Field Strength Outside 13.110 – 14.010MHz: Complied\*

**Part 15.225 e**

Frequency Tolerance: Complied

\* This result falls within the laboratory's measurement uncertainty.

## 2.0 GENERAL INFORMATION

### 2.1 General Description of Test Sample

Manufacturer	:	Sato Vicinity
Test Sample	:	RFID Smart Cabinet
Model	:	PSC-6040
Serial Number	:	Production Prototype
FCC ID	:	2ACXQ-PSC-6040
Equipment Type	:	Intentional Radiator

### 2.2 Test Sample Description

The Smart Cabinet PSC-6040 is an RFID read/write cabinet designed to meet the requirements to manage tagging, monitor, and control a huge number of items. It is designed to work in office, medical and production environment.

The Smart Cabinet PSC-6040 will read and write to all PJM StackTag labels located within the shelves.

The unit consists of IEC main plug, and Ethernet ports. It has a built-in WiFi module.

Power is provided from an external MAINS.

## 2.3 Technical Specifications and System Overview

Data Cable : Ethernet cable minimum 3m in length  
Voltage : 100-240Vac  
Ports : Power port, RJ45 (Ethernet) port, Wifi antenna

### RFID Transmitter Component

Microprocessor : AT91RM9200  
Frequencies : 50MHz, 27.12MHz, 18.432MHz  
Transmission Frequency : 13.56 MHz (RFID)  
Real Time Clock : 32, 768kHz

### Cabinet Component

Microprocessor : Exynos5422  
Frequencies : 2GHz, 1.5 GHz, 32.768kHz  
Case Style & Material :

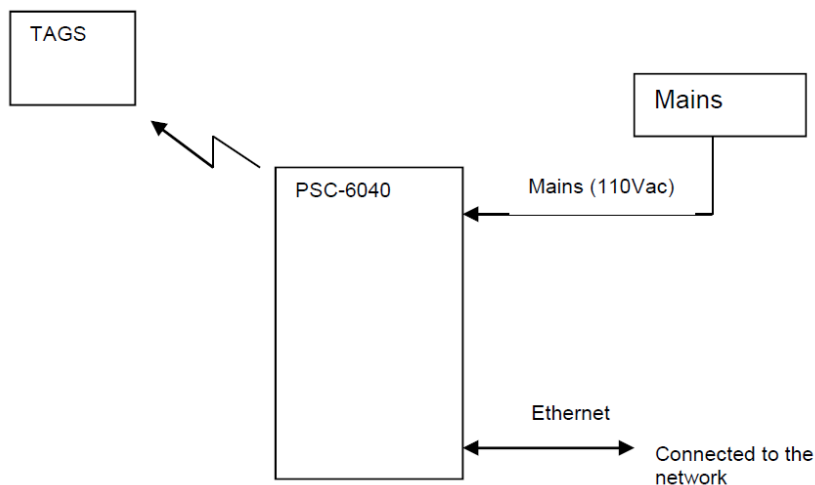
### Power Supply

Manufacturer : Concon Electronics  
Model : TRG100A120  
Input : 90-264V  
Freq: : 47-63Hz  
Output : 12V, 8.34A  
EMC : FCC Class B compliant  
Safety : UL60950-1 compliant

For further details please refer to Appendix L User Manual and Appendix G Customer Test Plan.

## 2.4 EUT Configurations

The PSC-6040 was tested with all the ports connected as depicted in the configuration diagram.



## **2.5 Test Sample Support Equipment**

The following auxiliary equipment will be used during testing:

- PJM Tags

## **2.6 Test Sample Block Diagram**

Please refer to Appendix E.

## **2.7 EUT Operation Conditions**

During the testing, the PSC-6040 will operate as a standalone system.

The unit will be polling the antenna during the test cycle. Some auxiliary functions of the cabinet, not relating to the transmitter circuit have been switched off during the testing.

## **2.8 Modifications**

No modifications were performed.

## **2.9 Test Procedure**

Radiated Emissions measurements were performed in accordance with the procedures of ANSI C63.4:2003. The measurement distance for radiated emissions was 3 metres from the EUT for the frequency range 9kHz-1000MHz.

## 2.10 Test Facility

### 2.10.1 General

Conducted Emission measurements were performed at EMC Technologies Laboratory in Seven Hills, New South Wales, Australia. Radiated Emission measurements in the ranges 9kHz-1000MHz were performed at EMC Technologies' indoor open area test site (iOATS) in Seven Hills, New South Wales, Australia.

The above sites have been fully described in a report submitted to the FCC office, and accepted in a letter dated February 25, 2015, **FCC Registration number is 411703.**

### 2.10.2 NATA Accreditation

EMC Technologies is accredited in Australia to test to the following standards by the National Association of Testing Authorities (NATA).

***“FCC Part 15 unintentional and intentional emitters in the frequency range 9kHz to 18GHz excluding TV receivers (15.117 and 15.119), TV interface devices (15.115), cable ready consumer electronic equipment (15.118), cable locating equipment (15.213) and unlicensed national information infrastructure devices (Sub part E).”***

The current full scope of accreditation can be found on the NATA website:

[www.nata.asn.au](http://www.nata.asn.au)

It also includes a large number of emission, immunity, SAR, EMR and Safety standards.

NATA is the Australian national laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO17025 requirements. A major requirement for accreditation is the assessment of the company and its personnel as being technically competent in testing to the standards. This requires fully documented test procedures, continued calibration of all equipment to the National Standard at the National Measurements Institute (NMI) and an internal quality system to ISO 9002. NATA has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (A<sup>2</sup>LA).

## 2.11 Units of Measurements

### 2.11.1 Conducted Emissions

Measurements are reported in units of dB relative to one microvolt (dB $\mu$ V).

### 2.11.2 Radiated Emissions

Measurements are reported in units of dB relative to one microvolt per metre (dB $\mu$ V/m). The measurement distance was 3 metres from the EUT for ranges 9kHz-1000MHz.

## 2.12 Test Equipment Calibration

All measurement instrumentation and transducers were calibrated in accordance with the applicable standards by an independent NATA registered laboratory such as Agilent Technologies (Australia) Pty Ltd or the National Measurement Institute (NMI). All equipment calibration is traceable to Australia national standards at the National Measurement Institute. The reference antenna calibration was performed by NMI and the working antennas (biconical and log-periodic) calibrated by the NATA approved procedures. The complete list of test equipment used for the measurements, including calibration dates and traceability is contained in Appendix A of this report.

## 2.13 Ambients at OATS

The Open Area Test Site (OATS) is an area of low background ambient signals. No significant broadband ambients are present however commercial radio and TV signals exceed the limit in the FM radio, VHF and UHF television bands. Radiated prescan measurements were performed in the shielded enclosure to check for possible radiated emissions at the frequencies where the OATS ambient signals exceeded the test limit.

## 3.0 CONDUCTED EMISSION MEASUREMENTS

### 3.1 Test Procedure

The arrangement specified in ANSI C63.4:2003 was adhered to for the conducted EMI measurements. The EUT was placed in the RF screened enclosure and a CISPR EMI Receiver as defined in ANSI C63.2-1987 was used to perform the measurements.

The EMI Receiver was operated under program control using the Max-Hold function and automatic frequency scanning, measurement and data logging techniques. The specified 0.15 MHz to 30 MHz frequency range was sub-divided into sub-ranges to ensure that all duration peaks were captured.

### 3.2 Peak Maximizing Procedure

For each of the sub-ranges, the EMI receiver was set to continuous scan with the Peak detector set to Max-Hold mode. The Quasi-Peak detector was then invoked to measure the actual Quasi-Peak level of the most significant peaks which were detected.

The highest recorded EMI signals are shown on the Peaks List on the bottom right side of the graph. Peaks that were greater than 20dB below the limit were not measured. For each numbered peak the frequency, peak field strength, Quasi-peak field strength, Average field strength and the margin relative to the limit in dB is listed. A negative margin is the level below the limit.

### 3.3 Calculation of Voltage Levels

The voltage levels were automatically measured in software and compared to the test limit. The method of calculation was as follows:

$$V_{EMI} = V_{RX} + L_{BPF}$$

Where:

$V_{EMI}$	=	The Measured EMI voltage in dB $\mu$ V to be compared to the limit.
$V_{RX}$	=	The Voltage in dB $\mu$ V read directly at the EMI receiver.
$L_{BPF}$	=	The insertion loss in dB of the cables and the Limiter and Pass Filter.



### 3.4 Plotting of Conducted Emission Measurement Data

The measurement data pertaining to each frequency sub-range were then concatenated to form a single graph of (peak) amplitude versus frequency. This was performed for both Active and Neutral lines and the composite graph was subsequently plotted. A list of the highest relevant peaks and the respective Quasi-Peak and Average values were also plotted on the graphs.

### 3.5 Conducted EMI Results

#### 3.5.1 Transmitter Terminals Connected to Antenna

Frequency MHz	Line	Measured QP Value dB $\mu$ V	QP Limit dB $\mu$ V	$\Delta$ QP $\pm$ dB	Measured Av. Value dB $\mu$ V	AV Limit dB $\mu$ V	$\Delta$ AV $\pm$ dB
13.56*	Neutral	42.0	50.0	-8.0	42.0	60.0	-18.0
13.56*	Active	40.5	50.0	-9.5	40.4	60.0	-19.6

\* Fundamental Frequency of Transmitter

The highest emission was at 13.56 MHz on the Neutral line, which were measured 8.0 dB below the Quasi-peak and greater than 10 dB below the Average limits.

Refer to Appendix K, Graphs 1 and 2.

#### 3.5.2 Transmitter Terminals Connected to a Resistive Load

The conducted emissions measurements with the antenna connected did not exceed the limits. Therefore additional testing with the antenna replaced by a resistive load is not applicable.

### 3.6 Results of Conducted Emission Measurement

The EUT complied with the limits of FCC Rule Part 15 Subpart C – Intentional Radiators.

## 4.0 RADIATED EMISSION MEASUREMENTS – 9 kHz to 1 GHz

### 4.1 Frequency Range of Radiated Measurements

The highest frequency of the EUT's transmitter circuit is 50 MHz (refer to section 2.3 of this report).

Highest frequency generated or used in the device or on which the device operates or tunes [MHz]	Upper frequency of measurement range [MHz]
1.705 - 108	1000
108 – 500	2000
500 – 1000	5000
Above 1000	10 <sup>th</sup> harmonic of the highest frequency or 40 GHz, whichever is lower

Frequencies above 1 GHz: Average trace taken (RBW 1MHz, VBW 100 kHz)

According to the table in FCC Part 15, Section 15.33 and the highest radio frequency signal generated or used in the EUT' transmitter circuit is 50 MHz, the radiated emissions measurement were performed from 9 kHz to 1000 MHz.

### 4.2 Test Procedure

Radiated emissions measurements were performed in accordance with the procedures of ANSI C63.4:2003 Radiated emission tests from 9 kHz to 1GHz were performed at the Open Area Test Site (OATS) an EUT distance of 3 metres. OET Bulletin 65 was used for reference.

The EUT was placed on a timber table 0.8m above an inground and operated in accordance with section 2 of this report. The EMI Receiver was operated under software control via the PC Controller.

#### 4.2.1 0.009 – 30 MHz Range

The 0.009 MHz to 30 MHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the Peak Detector set to Max-Hold. The receive loop antenna was set to 1m above the ground plane with the Quasi-Peak detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. The orientation of the receive loop antenna was varied to ensure that the emissions were maximised. The EUT was further rotated through three orthogonal directions to ensure worst case emissions are measured. The carrier test was performed at the worst-case operation voltage.

**Measurement distance:**

If the measurements were performed at a distance closer than that specified in the regulation, then the results would have been extrapolated by using the square of an inverse linear distance extrapolation factor (40 dB/decade) as described in Section 15.31 (f) (2).

#### 4.2.2 30 – 1000 MHz Range

The 30 MHz to 1000 MHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the Peak Detector set to Max-Hold. The EUT was further rotated through three orthogonal directions to ensure worst case emissions are measured. This was performed for two receiver antenna heights. Each significant peak was then investigated and maximised by rotating the turntable and scanning the height of the receiver antenna between 1 to 4 metres with the Quasi-Peak detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. This process was performed for both horizontal and vertical receive antenna polarisation.

### 4.3 Plotting of Measurement Data for Radiated Emissions

#### 4.3.1 0.009 – 30 MHz Range

The stored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 0.009 – 30 MHz. The fundamental frequency was measured at the OATS. The worst case radiated EMI peak measurements as recorded using the Max-Hold data are presented as the **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the “#” symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with “#” symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right hand side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, Quasi-peak field strength, limit and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit. At times, the quasi-peak level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the QP detector AFTER the MAX-HOLD trace has been stored. This will be apparent when the peaks list at the foot of the graphs shows the quasi peak level higher than the peak level.

### 4.3.2 30 – 1000 MHz

The stored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 30 – 1000 MHz. The accumulated EMI (EUT ON) was plotted as the Red trace while the Ambient signals (AMBIENT) were plotted as Green trace. The worst case radiated EMI peak measurements (as recorded using the Max-Hold data are presented as the upper or **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the “#” symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with “#” symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right hand side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, Quasi-peak field strength, limit and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit. At times, the quasi-peak level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the QP detector AFTER the MAX-HOLD trace has been stored. This will be apparent when the peaks list at the foot of the graphs shows the quasi peak level higher than the peak level.

## 4.4 Calculation of Field Strength

The field strength was calculated automatically by the software using all the pre-stored calibration data. The method of calculation is shown below:

$$E = V + AF - G + L$$

Where:

<b>E</b>	=	Radiated Field Strength in dB $\mu$ V/m.
<b>V</b>	=	EMI Receiver Voltage in dB $\mu$ V. (measured value)
<b>AF</b>	=	Antenna Factor in dB/m (stored as a data array)
<b>G</b>	=	Preamplifier Gain in dB. (stored as a data array)
<b>L</b>	=	Cable insertion loss in dB. (stored as a data array)

### Example Field Strength Calculation

Assuming a receiver reading of 34.0 dB $\mu$ V is obtained at 90 MHz, the Antenna Factor at that frequency is 9.2 dB. The cable loss is 1.9dB while the preamplifier gain is 20dB.

$$34.0 + 9.2 + 1.9 - 20 = 25.1 \text{ dB}\mu\text{V/m}$$

## 4.5 Radiated Field Strength Measurement Results – Section 15.225

### 4.5.1 13.56 MHz Carrier Field Strength Measurement at 3m Antenna Distance

Frequency MHz	Peak Level dB $\mu$ V/m	Limit @ 3m dB $\mu$ V/m	Result $\pm$ dB
13.56	84.7	124.0	-39.3

The mains supply was varied as per Section 15.31e between 100V 60 Hz to 138V 60Hz to determine if the carrier amplitude varies with supply voltage. No variation was recorded. The test was performed at 120V 60Hz.

Complied with a margin of greater than 20dB with Section 15.225 Subpart a, b & c. Refer to Appendix K, Graph 3.

### 4.5.2 9 kHz to 30 MHz Field Strength Spurious Emissions at 3m Antenna Distance

Complied with a margin of greater than 20dB with Section 15.225 Supart d (15.209). The measurement uncertainty was  $\pm$ 4.6dB. Refer to Appendix K, Graphs 4 and 5.

### 4.5.3 30 - 1000MHz Field Strength Spurious Emissions –Section 15.225 d (15.209) at 3m Antenna Distance

Frequency (MHz)	Rx Antenna Polarisation	Quasi Peak Level (dB $\mu$ V/m)	Limit @ 3m (dB $\mu$ V/m)	$\Delta$ Result (dB)
67.77	Horizontal	37.0	40.0	-3.0
40.67	Vertical	36.6	40.0	-3.4
94.63	Horizontal	37.9	46.5	-5.6
30.08	Vertical	31.7	40.0	-8.3
94.78	Horizontal	34.9	43.5	-8.6
81.30	Horizontal	31.1	40.0	-8.9
94.92	Vertical	33.8	43.5	-9.7

#### Summary of Results

The highest radiated spurious emission was 3.0dB below the limit at 67.77 MHz for Horizontal Polarisation. The highest points on both Vertical and Horizontal are reported on the graphs Appendix K.

Refer to Appendix K, Graphs 6 and 7.

## 5.0 UNCERTAINTIES

EMC Technologies has evaluated the equipment and the methods used to perform the emissions testing. The estimated measurement uncertainties for emissions tests shown within this report are as follows:

#### Conducted Emissions

9kHz to 30 MHz  $\pm$ 3.2 dB

#### Radiated Emissions

9kHz to 30MHz  $\pm$ 4.1 dB

30MHz to 300MHz  $\pm$ 5.1 dB

300MHz to 1000MHz  $\pm$ 4.7 dB

1GHz to 18GHz  $\pm$ 4.6 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

## 6.0 FREQUENCY TOLERANCE (FCC Part 15 Sections 15.225e)

The frequency stability of the unit was verified under abnormal operating supply voltage and temperature.

FCC Sub Part C Section 15.225e.

### Supply Voltage Variation

The mains supply was lowered from 120V 60Hz to 102V (85% of nominal supply) and maintained until the frequency was stable. The mains supply was then increased from 120V 60Hz to 138V (115% of nominal supply) and maintained until the frequency was stable.

Nominal Voltage	Temperature	Voltage Variation	Frequency Reading [MHz]	Frequency Variation [%]
120 V	20 °C	85% (102 V)	13.559820	0.00
120 V	20 °C	115% (138 V)	13.559820	0.00

Maximum Frequency Variation to Nominal Frequency:

13.559820	0.00
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The frequency tolerance of the carrier signal was maintained within  $\pm 0.01\%$  of the operating frequency during the voltage variation test.

### Temperature Variation

The ambient temperature with a supply voltage of 120V 60Hz was varied between -20°C and +50°C. At each 10°C interval the temperature was maintained until the EUT temperature had stabilised. The frequency of the carrier was observed at each 10°C increments and compared to the nominal frequency.

Nominal Voltage	Ambient Temperature	Frequency Reading [MHz]	Frequency Variation [%]
120 V	-20 °C	13.559896	0.0003
120 V	-10 °C	13.559901	0.0004
120 V	0 °C	13.559889	0.0003
120 V	10 °C	13.559852	0.0000
120 V	20 °C	13.559852	0.0000
120 V	30 °C	13.559785	0.0005
120 V	40 °C	13.559735	0.0009
120 V	55 °C	13.559720	0.0010
120 V	-20 °C	13.559896	0.0003

Nominal Transmit Frequency	13.559820
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Maximum Frequency Variation to Nominal Frequency:		0.0010
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The frequency tolerance of the carrier signal was maintained within  $\pm 0.01\%$  of the operating frequency during the temperature variation test.

## 7.0 CONCLUSION

The RFID Smart Cabinet, Model: PSC-6040, FCC ID: 2ACXQ-PSC-6040, complied with the requirements of FCC Part 15 Rules for internal radiator when tested in accordance with FCC Part 15.31e, 15.207 and 15.225.

**Part 15.31e**

Amplitude stability with supply variation: Complied

**Part 15.207**

Conducted Emissions: Complied

**Part 15.225 a, b & c**

Carrier Signal Field Strength 13.110 – 14.010MHz: Complied

**Part 15.225 d (15.209)**

Field Strength Outside 13.110 – 14.010MHz: Complied

**Part 15.225 e**

Frequency Tolerance: Complied

**APPENDIX A**  
**MEASUREMENT INSTRUMENTATION DETAILS**

**SUBMITTED AS ATTACHMENT**



**APPENDIX B**  
**PHOTOGRAPHS TEST SETUP**

**SUBMITTED AS ATTACHMENT**

**APPENDIX C**  
**PHOTOGRAPHS TEST SAMPLE (EXTERIOR)**

**SUBMITTED AS ATTACHMENT**

**APPENDIX D**  
**PHOTOGRAPHS TEST SAMPLE (INTERIOR)**

**APPENDIX E**  
**BLOCK DIAGRAM**

**SUBMITTED AS ATTACHMENT**

**APPENDIX F**  
**TEST SAMPLE SCHEMATICS**

**SUBMITTED AS ATTACHMENT**

## **APPENDIX G**

### **TEST PLAN**

**SUBMITTED AS ATTACHMENT**

**APPENDIX H**  
**LABELLING SAMPLE**

**SUBMITTED AS ATTACHMENT**

**APPENDIX I**  
**FCC ID LABELLING - LOCATION**

**SUBMITTED AS ATTACHMENT**



**APPENDIX J**  
**OPERATION DESCRIPTION**

**SUBMITTED AS ATTACHMENT**

**APPENDIX K**  
**GRAPHS OF EMI MEASUREMENT**

**SUBMITTED AS ATTACHMENT**

**APPENDIX L**  
**USER MANUAL**

**SUBMITTED AS ATTACHMENT**