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FCC PART 15.225 CERTIFICATION TEST REPORT

CRANE PAYMENT INNOVATIONS, INC
EASICHOICE 4IN1+

WLL REPORT# **15977-01 Rev 0**
March 15, 2019

FCC ID: QP8-4IN1TCORE

Prepared for:

CRANE PAYMENT INNOVATIONS, INC
3222 Phoenixville Pike, Suite 200
Malvern, PA, 19355

Prepared By:

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7560 Lindbergh Drive
Gaithersburg, Maryland 20879

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For the
CRANE PAYMENT INNOVATIONS, INC
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Prepared by:

Michael Violette
CEO, Engineer

Reviewed by:

Steven D. Koster
President

Abstract

This report has been prepared on behalf of Crane Payment Innovations, Inc to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.225 of the FCC Rules. This Certification Test Report documents the test configuration and test results for the EasiChoice 4IN1+ unit.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.
The EasiChoice 4IN1+ complies with the limits for an Intentional Radiator device under FCC Part 15.225.
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Revision History	Reason	Date
Rev 0	Initial Release	March 5, 2019
Rev 1	Rev for ACB Comments	March 15, 2019

Table of Contents

Abstract ..... **ii**
1.1 Compliance Statement 1
1.2 Test Scope Summary 1
1.3 Contract Information 1
1.4 Test Dates 1
1.5 Test and Support Personnel 1
1.6 Abbreviations 2
2 Equipment Under Test **3**
2.1 EUT Identification & Description 3
2.2 Test Configuration 3
2.3 Testing Algorithm 4
2.4 Measurements 5
2.5 Test Location 5
2.6 Measurement Uncertainty 5
3 Test Equipment **7**
4 Test Results **8**
4.1 Occupied Bandwidth 8
4.2 Radiated Spurious Emissions: FCC §15.225, §15.209 8
4.3 Conducted Emissions (AC Power Line) FCC §15.207, RSS GEN §7.2.4 12
4.4 Frequency Stability: FCC Part §2.1055, §15.225 14

List of Tables

Table 1: Device Summary 3
Table 2: Expanded Uncertainty List 6
Table 3: Test Equipment 7
Table 4: Occupied Bandwidth Results 8
Table 5: Radiated Emissions Limits 9
Table 6: Radiated Emissions 11
Table 10: AC Power Conducted Emissions Test Data 13
Table 11: Frequency Stability Test Data 15

List of Figures

Figure 1: Test Configuration 4
Figure 2: Occupied Bandwidth 8

1.1 Compliance Statement

The EasiChoice 4IN1+ complies with the limits for an Intentional Radiator device under FCC Part 15.225.

1.2 Test Scope Summary

Tests for radiated and conducted emissions were performed. All measurements were performed in accordance with the 2013 version of ANSI C63.10. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

Test Specification	Specific Description	Date Completed	Result	Modifications (Y/N)
CFR47 Part 15.207, RSS Gen section 7.2.4	Class B Conducted Emissions – AC Power Ports	3/1/2019	Complied	No
CFR47 Part 15.209, RSS Gen section 7.2.5	Class B Radiated Emissions	3/1/2019	Complied	No
CFR47 Part 15.225, RSS 210 section A2.6	Field Strength	3/1/2019	Complied	No
CFR47 Part 15.225, RSS GEN section 4.7	Frequency Stability	3/1/2019	Complied	No
CFR47 Part 2.1049	Occupied Bandwidth	3/1/2019	Complied	No

1.3 Contract Information

Customer: Crane Payment Innovations, Inc
3222 Phoenixville Pike, Suite 200
Malvern, PA 19355

Purchase Order Number: 4500585991

Quotation Number: 71292

1.4 Test Dates

Testing was performed on the following date(s): March 1, 2019

1.5 Test and Support Personnel

Washington Laboratories, LTD Michael Violette

Customer Representative Daniel Mitchell

1.6 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**ere**s**
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**c**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**d**eci**B**el
dc	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga - prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo - prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega - prefix for 10^6 multiplier
m	**m**eter
µ	**m**icro - prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**umber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

2 Equipment Under Test

2.1 EUT Identification & Description

The EasiChoice 4IN1+ is a vending machine interface that provides closed network payment solutions. The EasiChoice 4IN1+ utilizes RFID tags pre-loaded with "cash" as a payment solution for the host vending machine. The RFID emission is based on ISO 14443 standard with a carrier center frequency of 13.56 MHz.

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Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Crane Payment Innovations, Inc
FCC ID:	QP8-4IN1TCORE
Model:	EasiChoice 4IN1+
FCC Rule Parts:	§15.225
Frequency Range:	13.56MHz
Maximum Output Power:	311 uV/m @ 13.56 MHz @ 3 m
Modulation:	CW
Occupied Bandwidth:	21.6 kHz
Type of Information:	CW
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Internal PCB
Frequency Tolerance:	>±0.01% (±100 ppm)
Interface Cables:	Power, I/O to host
Power Source & Voltage:	5Vdc from Host Device

2.2 Test Configuration

The EasiChoice 4IN1+ was connected to a power supply and a laptop to provide power and exercise the device.

The RFID antenna connects to the EasiChoice 4IN1+ via a MCX Coax cable and connector for RFID operation and a ribbon cable for status and audible indicators. No other connections were necessary.

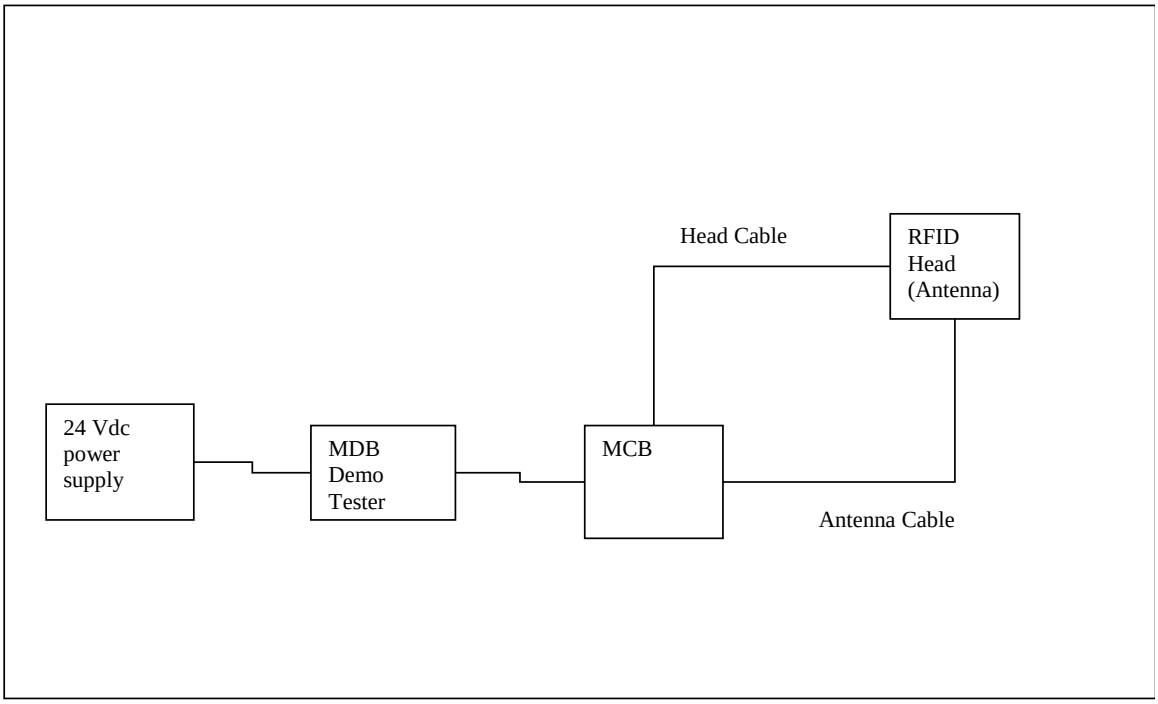


Figure 1: Test Configuration

2.3 Testing Algorithm

The EUT operates continuously when power is applied transmitting at 13.56MHz. The device is mounted in a vertical configuration on the host vending machine.

Worst case emission levels are provided in the test results data.

2.4 Measurements

2.4.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation
ANSI C63.10:2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

2.5 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2002) with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{div_a^2} + \frac{b^2}{div_b^2} + \frac{c^2}{div_c^2} + \ldots..}$$

Where u_c = standard uncertainty
a, b, c, = individual uncertainty elements
$div_{a,\ b,\ c}$ = the individual uncertainty element divisor based on the probability distribution
Divisor = 1.732 for rectangular distribution
Divisor = 2 for normal distribution
Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = k u_c$$

Where U = expanded uncertainty
k = coverage factor
k ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)
u_c = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 2 below.

Table 2: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	±2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	±4.55 dB

3 Test Equipment

Table 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment

Test Name:	**Conducted Emissions Voltage**	Test Date:	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
125	SOLAR - 8028-50-TS-24-BNC	LISN	5/23/2019
126	SOLAR - 8028-50-TS-24-BNC	LISN	5/23/2019
	AGILENT – N9010A	EXA SPECTRUM ANALYZER	4/21/2019
53	HP - 11947A	LIMITER TRANSIENT	2/1/2020

Test Name:	**Radiated Emissions**	Test Date:	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	4/21/2019
644	SUNOL SCIENCES CORPORATION - JB1 925-833-9936	BICONALOG ANTENNA	1/16/2020
276	HP 8446	RF PRE-AMPLIFIER	5/7/2019
856	EMCO - 6507	ACTIVE LOOP 1kHZ - 30MHZ	11/1/2019

Test Name:	**Temperature Stability**	Test Date:	**3/1/2019**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
776	TENNY - TJR-A-WS4	1.22 CUFT	6/1/2019
	RACAL 1992	RACAL FREQUENCY COUNTER	4/21/2019

4 Test Results

4.1 Occupied Bandwidth

Occupied bandwidth measurement was performed by coupling the output of the EUT to the input of a spectrum analyzer using a near field probe. Table 4 provides a summary of the Occupied Bandwidth Results.

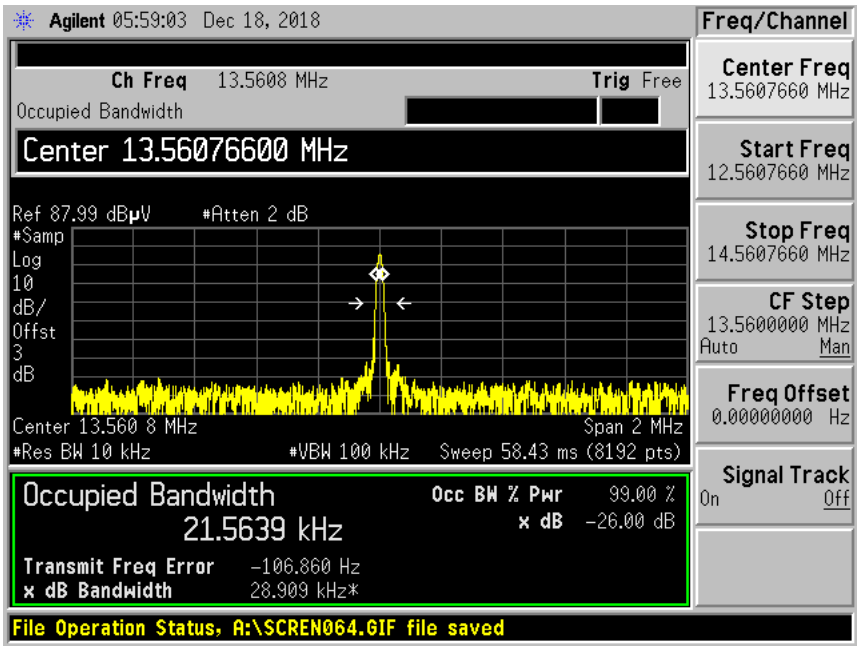
The signal was an unmodulated CW

Table 4: Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
13.560MHz	21.6 kHz	N/A	Pass

The occupied bandwidth was measured as shown:

Figure 2: Occupied Bandwidth



4.2 Radiated Spurious Emissions: FCC §15.225, §15.209

Radiated emissions from the EUT must comply with the field strength limits as specified in FCC Part 15.225 and 15.209 and IC RSS 210 and RSS GEN. The limits for the radiated emissions are as shown in the following table.

Table 5: Radiated Emissions Limits

Frequency (MHz)	Limit (μV/m)	Rule Part Reference
13.553 - 13.567	15,848 (@ 30m)	§15.225(a), §RSS 210 A2.6(a)
13.410 – 13.553	334 (@ 30m)	§15.225(b), §RSS 210 A2.6(b)
13.567 – 13.710	334 (@ 30m)	§15.225(b), §RSS 210 A2.6(b)
13.110 – 13.410	106 (@ 30m)	§15.225(c), §RSS 210 A2.6(c)
13.710 – 14.010	106 (@ 30m)	§15.225(c), §RSS 210 A2.6(c)
1.705 – 13.110 14.010 – 30.0	30 (@ 30m)	§15.225(d), §RSS 210 A2.6(c) §15.209, RSS GEN 7.2.5
30.00 – 88.00	100 (@ 3m)	§15.225(d), §RSS 210 A2.6(d) §15.209, RSS GEN 7.2.5
88.00 – 216.00	150 (@ 3m)	§15.225(d), §RSS 210 A2.6(d) §15.209, RSS GEN 7.2.5
216.00 – 960.00	200 (@ 3m)	§15.225(d), §RSS 210 A2.6(d) §15.209, RSS GEN 7.2.5
Above 960	500 (@ 3m)	§15.225(d), §RSS 210 A2.6(d) §15.209, RSS GEN 7.2.5

4.2.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on an Open Area Test Site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. For frequencies below 30MHz, the loop antenna was mounted on a tripod at a height of 1 meter and a distance of 10m from the EUT. Above 30MHz, Biconical and log periodic broadband receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters at a distance of 3 meters from the EUT. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

Below 150 kHz, bandwidths used were 300Hz RBW and 10 kHz VBW. Between 150 kHz and 30MHz, bandwidths used were 10kHz RBW and 30kHz VBW. Measurements were performed at 3 m. A correction factor was used to adjust the 3 meter results to the equivalent at 30 meters using the 20dB/decade roll-off. Three orientations of the loop antenna were tested. Above 30MHz, bandwidths used were 100 kHz RBW and 30kHz VBW.

Emissions were scanned from 9 kHz to 2GHz. Emissions from were measured using a peak detector. Worst case emissions are reported in the data table.

The following is a sample calculation used in the data tables for calculating the final field strength of spurious emissions and comparing these levels to the specified limits.

Sample Calculation:

Spectrum Analyzer Voltage (SA Level): VdBμV
Antenna Factor (Ant Corr): AFdB/m
Cable Loss Correction (Cable Corr): CCdB

Amplifier Gain:	GdB (if applicable)
Electric Field (Corr Level):	EdBμV/m = VdBμV + AFdB/m + CCdB - GdB
To convert to linear units:	EμV/m = antilog (EdBμV/m/20)

4.2.2 Test Results

The EUT complies with the radiated emission requirements of §15.225. The following tables provide the test data. Peak readings were taken of the emissions and at harmonics of the fundamental.

The processer in the unit sports a 500 MHz clock, so emissions scans were performed to 2 GHz.

Table 6: Radiated Emissions

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
13.56	X	0	1.50	58.10	-15.1	140.6	150848.0	-60.6	Peak
13.56	Y	90	1.50	65.00	-15.1	311.1	150848.0	-53.7	Peak
13.56	Z	0	1.50	52.00	-15.1	69.6	150848.0	-66.7	Peak
27.12	X	90	1.50	14.00	-16.7	0.7	300.0	-52.2	NF
27.12	Y	0	1.50	15.30	-16.7	0.9	300.0	-50.9	NF
27.12	Z	180	1.50	15.60	-16.7	0.9	300.0	-50.6	NF
40.68	H	0	1.50	26.50	-17.3	2.9	100.0	-30.8	NF
54.24	H	0	1.50	32.50	-17.1	5.9	100.0	-24.6	NF
67.80	H	0	1.50	31.80	-16.9	5.5	100.0	-25.1	NF
81.36	H	0	1.50	32.20	-16.8	5.9	100.0	-24.6	NF
108.48	H	0	1.50	27.90	-16.5	3.7	150.0	-32.1	NF
122.04	H	0	1.50	28.80	-16.4	4.2	150.0	-31.1	NF
135.60	H	0	1.50	29.80	-16.3	4.7	150.0	-30.0	NF
500.00	H	0	1.00	30.00	-14.1	6.3	200.0	-30.1	NF
2000.00	H	0	1.00	24.86	-12.3	4.2	500.0	-41.4	NF
40.68	V	0	0.00	33.00	-17.3	6.1	100.0	-24.3	NF
54.24	V	0	0.00	43.10	-17.1	19.9	100.0	-14.0	NF
67.80	V	0	0.00	35.40	-16.9	8.4	100.0	-21.5	NF
81.36	V	0	0.00	36.40	-16.8	9.6	100.0	-20.4	NF
94.92	V	0	0.00	30.20	-16.6	4.8	150.0	-29.9	NF
108.48	V	0	0.00	27.90	-16.5	3.7	150.0	-32.1	NF
122.04	V	0	0.00	29.90	-16.4	4.8	150.0	-30.0	NF
135.60	V	0	0.00	33.20	-16.3	7.0	150.0	-26.6	NF
500.00	V	0	0.00	27.70	-14.1	4.8	200.0	-32.4	NF
2000.00	V	0	0.00	26.00	-12.3	4.8	500.0	-40.3	NF

NF: Noise Floor

4.3 Conducted Emissions (AC Power Line) FCC §15.207, RSS GEN §7.2.4

The EUT was placed on an 80 cm high 1 x 1.5 m non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 x 2-meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak or peak, as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth.

All emissions were measured with the EUT intact with the exception of the fundamental transmit frequency of 13.56MHz. To measure 13.56MHz, the internal antenna was replaced with a resistive load.

AC Power Line conducted emissions test data are included in Table 7.

Table 7: AC Power Conducted Emissions Test Data

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.279	31.0	28.7	10.2	0.3	41.5	39.2	60.8	50.8	-19.4	-11.7
0.385	26.7	14.4	10.2	0.3	37.2	24.9	58.2	48.2	-21.0	-23.3
0.442	24.4	23.5	10.2	0.3	34.9	34.0	57.0	47.0	-22.2	-13.0
2.490	25.4	25.4	10.1	0.3	35.8	35.8	56.0	46.0	-20.2	-10.2
2.760	26.6	14.1	10.2	0.3	37.1	24.6	56.0	46.0	-18.9	-21.4
25.367	20.5	11.4	11.7	1.2	33.4	24.2	60.0	50.0	-26.6	-25.8
28.010	16.0	11.0	11.9	1.2	29.1	24.1	60.0	50.0	-30.9	-25.9

PHASE

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.162	39.7	36.3	10.2	0.2	50.0	46.6	65.4	55.4	-15.3	-8.7
0.221	36.5	30.1	10.2	0.1	46.7	40.3	62.8	52.8	-16.1	-12.5
0.330	23.2	24.2	10.2	0.2	33.6	34.6	59.5	49.5	-25.9	-14.9
0.387	29.9	26.7	10.2	0.3	40.3	37.1	58.1	48.1	-17.8	-11.0
0.442	25.6	25.3	10.2	0.2	36.0	35.7	57.0	47.0	-21.0	-11.3
25.367	11.2	5.0	11.7	1.2	24.0	17.8	60.0	50.0	-36.0	-32.2
28.010	11.4	5.2	11.9	1.4	24.6	18.4	60.0	50.0	-35.4	-31.6

4.4 Frequency Stability: FCC Part §2.1055, §15.225

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances. Per §15.225(e) the frequency tolerance shall be maintained within ±0.01% of the reference frequency.

4.4.1 Test Procedure

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -20°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter.

The frequency stabilities can be maintained to a lesser temperature range provided that the transmitter is automatically inhibited from operating outside the lesser temperature range.

The RF carrier frequency shall not depart from the reference frequency (reference frequency is the frequency at 20ºC and rated supply voltage) in excess of +/-1356 Hz.

The EUT was powered by 24Vdc voltage.

Per ANSI 63.10 the EUT was tested at each temperature at the turn on point, 2-minute point, 5-minute point, and 10-minute point.

4.4.2 Test Results

The EUT complies with the temperature stability requirements of the specified standards. Test results are given in Table 8.

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Table 8: Frequency Stability Test Data

Temperature Variation

Temperature (C)	Frequency (MHz)	Deviation (Hz)	Limit (+/- Hz)	Pass/Fail
22(ambient)	13.560500	0	1356	**NA**
-20	13.560500	0	1356	Pass
-10	13.560506	6	1356	Pass
0	13.560500	0	1356	Pass
10	13.560500	0	1356	Pass
20	13.560400	-100	1356	Pass
30	13.560575	75	1356	Pass
40	13.560573	73	1356	Pass
50	13.560541	41	1356	Pass

Voltage Variation

Voltage	Frequency (MHz)	Deviation (Hz)	Limit (+/-Hz)	Pass/Fail
Nominal Voltage	13.560543	0	1356	**NA**
110% (Vdc)	13.560542	-1	1356	Pass
85 (Vdc)	13.560540	-3	1356	Pass