Testing Tomorrow's Technology

Class 2 Permissive Change Test Report

per

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraphs 15.207, 15.209 and 15.247

For the

Control Data Systems

Model: VN210

FCC ID: 2AKZ5-CDSVN210ISA

UST Project No.: 18-0412

Test Date(s): December 7, 2018 to January 2, 2019
Issue Date: March 6, 2019

Total Pages in This Report: 21

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I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date March 6, 2019

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Control Data Systems

MODEL: VN210

FCC ID: 2AKZ5-CDSVN210ISA

DATE: March 6, 2019

This report concerns (check one): Original grant
Class 2 change [X]

Equipment type: 2400 to 2483.5 MHz Transceiver

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes_____ No X

If yes, defer until: _____N/A_____
date
agrees to notify the Commission by N/A
date
of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

US Tech
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1 General Information

1.1 Purpose of this Report

The client is requesting that the radio module be approved for co-location applications. The client has provided the test lab with an evaluation board that will allow the test lab to test two radio modules co-located together. The radio module has not changed from its original filing. The intent of this test is to show that the radio will continue to meet the applicable limits when co-located on a single host board. The radios can simultaneously broadcast; however they do not share a common antenna port and they do operate independently from each other.

Based on the reques,t the spurious emissions of the co-located radios have been evaluated for continued compliance. An evaluation of RF exposure has also been performed. That data is provided in a separate exhibit.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on December 3, 2018 in good operating condition.

1.3 Product Description

The module provides general purpose analog and digital I/O for use by the applications board (see module schematic). The module firmware implements the Nivis Mesh protocol.

This module is a direct sequence spread spectrum transceiver operating in the 2400 MHz to 2483.5 MHz ISM band. The system is based on the IEEE 802.15.4 Wireless Personal Area Network (WPAN) standard, with channels spaced at 5 MHz intervals in the ISM band. The system operates at a chip rate of 2 Mcps, a symbol rate of 62.5 kbps, and a bit rate of 250 kbps. O-QPSK modulation is used with 16-ary orthogonal symbols.

An input supply of 3.3 VDC is supplied to the RF module using buck-boost power supply. The module transmits with a maximum power of +10 dBm into the onboard MMCX connector. This module does not transmit for more than 42.35 ms over any 100 ms time period.

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices*.

A list of EUT and Peripherals is found in Table 1 following. A block diagram of the tested system is shown in Figure 1. Test configuration photographs are provided in separate Appendices.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is US5301. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittals

The EUT is currently approved as an intentionally transmitting device under FCC ID: 2AKZ5-CDSVN210ISA

No other related submittals apply.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER.	MODEL NUMBER	SERIAL NUMBER	FCC ID	CABLES P/D
Radio module (x2) Control Data Systems	VN210	Engineering Sample	2AKZ5-CDSVN210ISA	N/A
Evaluation board Control Data Systems	VR800	Engineering Sample	None	N/A
PoE device Various	Various	Various	None	1.5 m P

U= Unshielded S= Shielded
P= Power D= Data

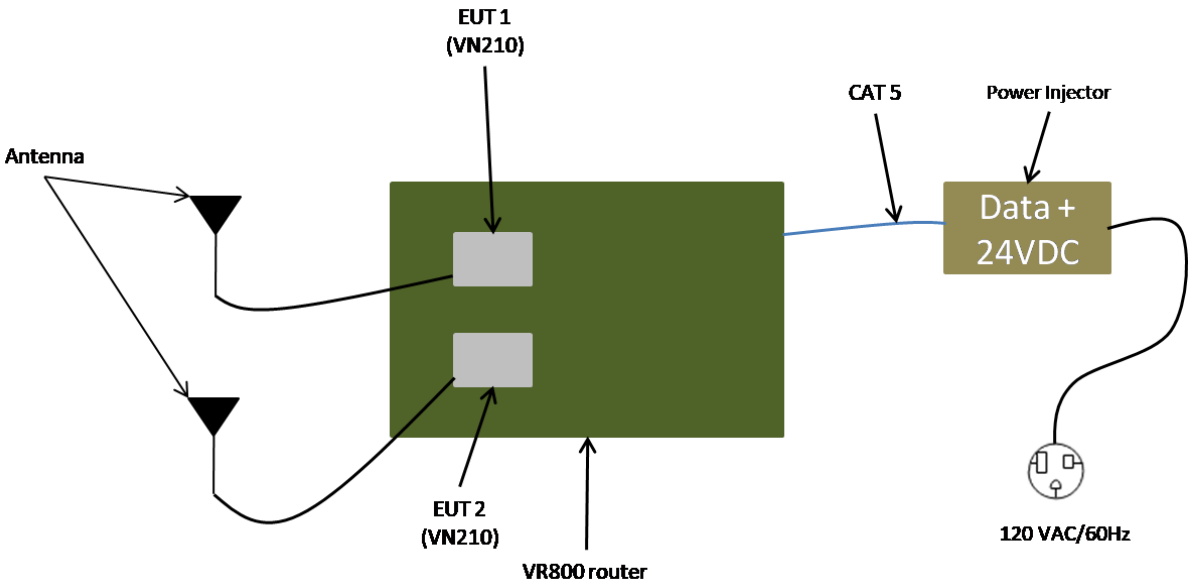


Figure 1. Block Diagram of Test Configuration

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers, and calibration status are indicated.

Table 2. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	Calibration Due Date
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	8/17/2020 2 yr.
LOOP ANTENNA	6502	EMCO	9810-3246	1/22/2020 2 yr
BICONNICAL ANTENNA	3110B	EMCO	9306-1708	5/2/2019 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	5/1/2019 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	11/28/2020 2 yr
PREAMP	8447D	HEWLETT-PACKARD	1937A02980	3/7/2019
PREAMP	8449B	HEWLETT-PACKARD	3008A00480	6/4/2019
HIGH PASS FILTER	H3R020G2	MICROWAVE CIRCUITS	001DC9528	3/8/2019

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No physical modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15, Subpart C Intentional Radiator Limits for the transmitter portion of the EUT

2.3 Number of Measurements for Intentional Radiators (15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in Table 3 below.

Table 3. Number of Test Frequencies for Intentional Radiators

Frequency Range over which the device operates	Number of Frequencies	Location in the Range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

2.4 Frequency Range of Radiated Measurements (Part 15.33)

2.4.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10^{th} harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the following:

Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the Quasi-peak device are used.

Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding Peak requirement, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz.

Pulsed Transmitter Averaging

When the radiated emissions limit is expressed as an average value, and the transmitter is pulsed, the measured field strength shall be determined by applying a Duty Cycle Correction Factor based upon dividing the total ON time during the first 100 ms period by 100 ms (or by the period if less than 100 ms). The duty cycle may be expressed logarithmically in dB.

NOTE: If the transmitter was programmed to transmit at >98% duty cycle, then, wherever applicable (where the detection mode was AVG) the duty cycle factor calculated will be applied.

The duty cycle de-rating factor used in the calculation of average radiated limits (per CFR 15.209 and 15.35(c)) is described below. This factor was calculated by first determining the worst case scenario for system operation. The worst case operating scenario is as follows:

The transmission duty cycle is calculated as:
Total ON time: 43.52 milliseconds (43.52 mS/100 mS)*100% = 43.5%

In terms of logarithmic voltage (dB); 20 log (0.4352) = - 7.23 dB

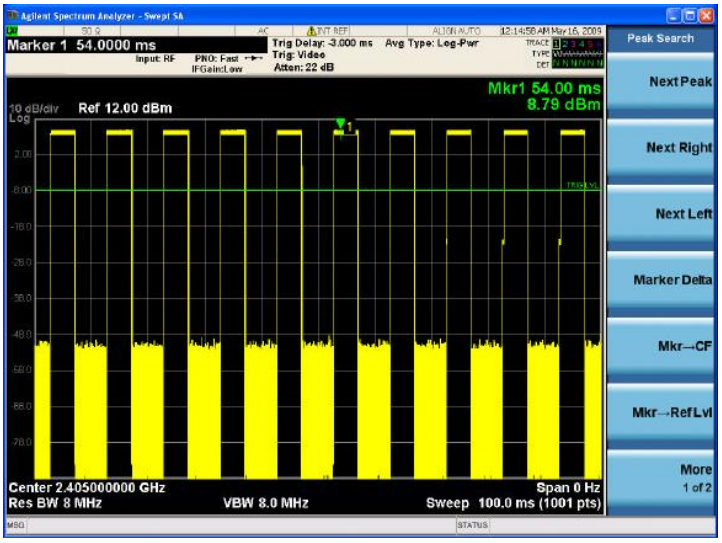


Figure 2. Transmission Duty Cycle

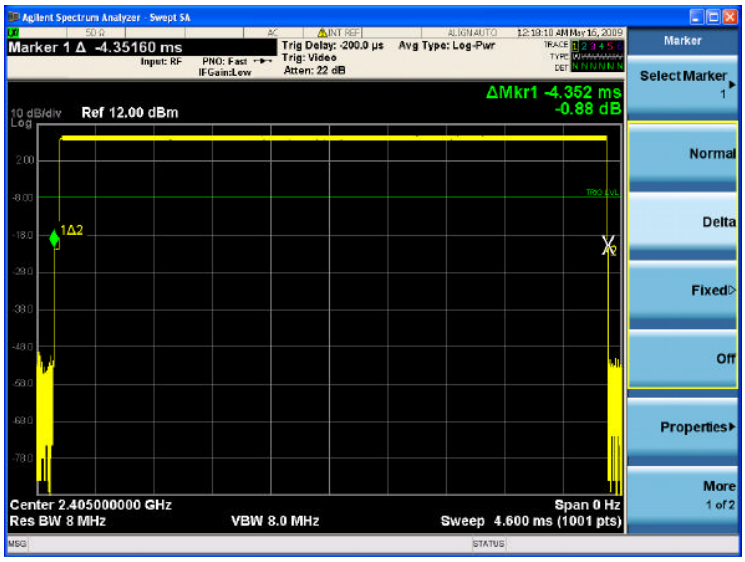


Figure 3. Transmission Pulse Width

2.6 EUT Antenna Requirements (CFR 15.203)

This equipment is not available to the general public and will only be installed by a professional installer working for an approved utility. The equipment therefore meets the intent of this requirement. Only the antenna being added, listed in Table 4, was used for the testing described in this test report. For information about the other antennas used with this equipment please see the original certification report.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
Antenna	Linx Technologies	Dipole antenna	ANT-2.4-CW-RCT-RP	2.2	mmcx

2.7 Restricted Bands of Operation (Part 15.205)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these emissions cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement. See paragraph 2.8 of the test report.

2.8 Intentional Radiator Radiated Emissions (CFR 15.209, 15.247(d))

Radiated Spurious measurements: The EUT was placed into a continuous transmit mode of operation (>98% or max level possible duty cycle) and tested per ANSI C63.10:2013. The EUT was tested in the orientation of normal operation because the device is designed to operate in a fixed position.

Radiated measurements were performed in the frequency range of 9 kHz (or lowest frequency used/generated by the device) up to the tenth harmonic of the device (not greater than 40 GHz). In the band below 150 kHz, a resolution bandwidth (RBW) of 200 Hz was used. In the band from 150 kHz to 30 MHz, a RBW of 9 kHz was used, emissions below 1 GHz were tested with a RBW of 100/120 kHz and emissions above 1 GHz were tested with a RBW of 1 MHz. All video bandwidth settings were at least three times the RBW value.

The host board with co-located radio was tested with both radio boards on active. Spurious emissions from with both boards on and active are recorded in the tables below. Each radio was then tested for Intentional emissions, Fundamental and harmonics emissions to ensure that the co-located configuration did not cause the radios to emit emissions that would exceed the Part 15.247 (d) limits. The test data for each radio, RADIO 1 and RADIO 2 is also presented below.

Table 5. RADIO 1 Average Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Control Data Systems			
Project: 18-0412				**Model:** VN210			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel							
2405.00	108.70	-2.75	105.95	--	3.0m/HORZ	--	**AVG**
4810.00*	38.63	7.44	46.07	54.0	3.0m/HORZ	7.9	**AVG**
4810.00*	38.32	7.47	45.79	54.0	3.0m/VERT	8.2	**AVG**
Middle Channel							
2440.00	109.50	-2.67	106.83	--	3.0m/VERT	--	**AVG**
4880.00*	42.53	6.78	49.31	54.0	3.0m/VERT	4.7	**AVG**
4880.00*	39.34	6.75	46.09	54.0	3.0m/HORZ	7.9	**AVG**
7320.00*	30.35	5.34~	35.69	54.0	1.0m/VERT	18.3	**AVG**
7320.00*	36.76	5.25~	42.01	54.0	1.0m/HORZ	12.0	**AVG**
High Channel							
2475.00	107.30	-2.74	104.56	--	3.0m/VERT	--	**AVG**
4950.00*	41.14	6.80	47.94	54.0	3.0m/VERT	6.1	**AVG**
4950.00*	45.69	6.86	52.55	54.0	3.0m/HORZ	1.5	**AVG**
7425.00*	36.08	5.97~	42.05	54.0	1.0m/HORZ	12.0	**AVG**
All other emissions greater than 20 dB from the applicable limit.							

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. (*) The EUT was transmitting at > 98% duty cycle therefore a duty cycle correction factor of -7.23 dB is applied to correct the measurement.

Sample Calculation at 4810.00 MHz:

Magnitude of Measured Frequency	38.63	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	7.44	dB/m
Corrected Result	46.07	dBuV/m

Test Date: December 26, 2018
Tested By
Signature: _____ Name: Mark Afroozi

Table 6. RADIO 1 Peak Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Control Data Systems			
Project: 18-0412				**Model:** VN210			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – PK							
2405.00	110.80	-2.75	108.05	--	3.0m/HORZ	--	**PK**
4810.00*	51.98	7.44	59.42	74.0	3.0m/HORZ	14.6	**PK**
4810.00*	51.59	7.47	59.06	74.0	3.0m/VERT	14.9	**PK**
Middle Channel							
2440.00	109.50	-2.67	106.83	--	3.0m/VERT	--	**PK**
4880.00*	57.27	6.78	64.05	74.0	3.0m/VERT	9.9	**PK**
4880.00*	55.00	6.75	61.75	74.0	3.0m/HORZ	12.2	**PK**
7320.00*	52.41	5.34~	57.75	54.0	1.0m/VERT	16.3	**PK**
7320.00*	54.71	5.25~	59.96	54.0	1.0m/HORZ	14.0	**PK**
High Channel							
2475.00	107.30	-2.74	104.56	--	3.0m/VERT	--	**PK**
4950.00*	54.12	6.80	60.92	74.0	3.0m/VERT	13.1	**PK**
4950.00*	62.55	6.86	69.41	74.0	3.0m/HORZ	4.6	**PK**
7425.00*	60.22	5.97~	66.19	74.0	1.0m/HORZ	7.8	**PK**
All other emissions greater than 20 dB from the applicable limit.							

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than its normal operating duty cycle. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 4810.00 MHz:

Magnitude of Measured Frequency	51.98	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	7.44	dB/m
Corrected Result	59.42	dBuV/m

Test Date: December 26, 2018
Tested By
Signature: _____ Name: Mark Afroozi

Table 7. RADIO 2 Average Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Control Data Systems			
Project: 18-0412				**Model:** VN210			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel							
2405.00	107.30	-2.57	104.73	--	3.0m/VERT	--	**AVG**
4810.00*	43.82	7.47	51.29	54.0	3.0m/VERT	2.7	**AVG**
4810.00*	42.54	7.44	49.98	54.0	3.0m/HORZ	4.0	**AVG**
Middle Channel							
2440.00	101.80	-2.85	98.95	--	3.0m/HORZ	--	**AVG**
4880.00*	52.45	-0.48*	51.97	54.0	3.0m/HORZ	2.0	**AVG**
4880.00*	52.61	-0.45*	52.16	54.0	3.0m/VERT	1.8	**AVG**
7320.00*	43.83	5.25~	49.08	54.0	1.0m/HORZ	4.9	**AVG**
7320.00*	38.69	5.34~	44.03	54.0	1.0m/VERT	10.0	**AVG**
High Channel							
2475.00	107.70	-2.74	104.96	--	3.0m/VERT	--	**AVG**
4950.00*	46.46	-0.37*	46.09	54.0	3.0m/HORZ	7.9	**AVG**
4950.00*	43.82	-0.43*	43.39	54.0	3.0m/VERT	10.6	**AVG**
All other emissions greater than 20 dB from the applicable limit.							

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. (*) The EUT was transmitting at > 98% duty cycle therefore a duty cycle correction factor of -7.23 dB is applied to correct the measurement.

Sample Calculation at 4810.00 MHz:

Magnitude of Measured Frequency	43.82	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	7.47	dB/m
Corrected Result	51.29	dBuV/m

Test Date: December 26, 2018
Tested By
Signature: _____ Name: Mark Afroozi

Table 8. RADIO 2 Peak Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Control Data Systems			
Project: 18-0412				**Model:** VN210			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel							
2405.00	109.20	-2.57	106.63	--	3.0m/VERT	--	**AVG**
4810.00*	58.62	7.47	65.83	74.0	3.0m/VERT	8.2	**AVG**
4810.00*	58.13	7.44	65.57	74.0	3.0m/HORZ	8.4	**AVG**
Middle Channel							
2440.00	103.90	-2.85	101.05	--	3.0m/HORZ	--	**AVG**
4880.00*	59.40	6.75	66.15	74.0	3.0m/HORZ	7.8	**AVG**
4880.00*	62.61	6.78	69.39	74.0	3.0m/VERT	4.6	**AVG**
7320.00*	55.27	5.25~	60.52	74.0	1.0m/HORZ	13.5	**AVG**
7320.00*	49.74	5.34~	55.08	74.0	1.0m/VERT	18.9	**AVG**
High Channel							
2475.00	109.50	-2.74	106.76	--	3.0m/VERT	--	**AVG**
4950.00*	60.60	6.86	67.46	74.0	3.0m/HORZ	6.5	**AVG**
4950.00*	61.74	6.80	68.54	74.0	3.0m/VERT	5.5	**AVG**
All other emissions greater than 20 dB from the applicable limit.							

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than its normal operating duty cycle. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 4810.00 MHz:

Magnitude of Measured Frequency	58.62	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	7.47	dB/m
Corrected Result	65.83	dBuV/m

Test Date: December 26, 2018
Tested By
Signature: _____ Name: Mark Afroozi

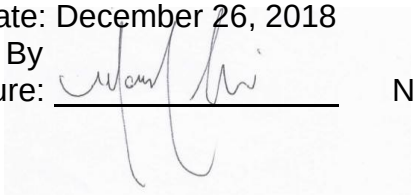


Table 9. Radiated Spurious Emissions Part 15.209, 150kHz to 30 MHz

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Control Data Systems			
Project: 18-0412				**Model:** VN210			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
No emissions seen greater than 20 dB below the applicable limit.							

Sample Calculation: N/A

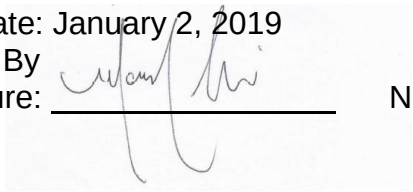
Test Date: January 2, 2019
Tested By
Signature: _____ Name: Mark Afroozi

Table 10. Radiated Spurious Emissions Part 15.209, 30 MHz to 25 GHz

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Control Data Systems			
Project: 18-0412				**Model:** VN210			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
58.11	52.20	-16.63	35.57	40.0	3m./HORZ	4.4	**PK**
99.98	50.08	-17.11	32.97	43.5	3m./HORZ	10.5	**PK**
124.97	55.35	-15.29	40.06	43.5	3m./HORZ	3.4	**PK**
150.02	46.42	-14.09	32.33	43.5	3m./HORZ	11.2	**PK**
200.00	53.38	-10.90	42.48	43.5	3m./HORZ	1.0	**PK**
200.00	43.19	-10.50	32.69	43.5	3m./VERT	10.8	**PK**
350.00	55.39	-10.25	45.14	46.0	3m./HORZ	0.9	**PK**
984.00	52.48	-1.45	51.03	54.0	3m./HORZ	3.0	**PK**
All other emissions were greater than 20 dB below the applicable limit.							

Sample Calculation at 58.11 MHz:

Magnitude of Measured Frequency	52.20	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-16.63	dB/m
Corrected Result	35.57	dBuV/m

Test Date: January 2, 2019
Tested By
Signature:  Name: Mark Afroozi

2.9 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4-2. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.18 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.21dB.

3 Conclusions

Based on the evaluation and test data presented, it can be determined that the additional antenna will not have any significant impact on the originally reported test data. This modification meets the requirements of a Class 2 Permissive Change as documented herein.