3D Systems Corporation

Mercury RFID module

FCC 15.225:2017
FCC 15.207:2017

13.56 MHz Radio

Report # 3DSY0090

NVLAP Lab Code: 200630-0

CERTIFICATE OF TEST

2017-1-25

Last Date of Test: November 20, 2017
3D Systems Corporation
Model: Mercury RFID module

Radio Equipment Testing

Standards

Specification	Method
FCC 15.225:2017	ANSI C63.10:2013
FCC 15.207:2017	

Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions	Yes	Pass	
6.4	Field Strength of Fundamental	Yes	Pass	
6.4	Field Strength of Spurious Emissions Less Than 30 MHz	Yes	Pass	
6.5	Field Strength of Spurious Emissions Greater Than 30 MHz	Yes	Pass	
6.8	Frequency Stability	Yes	Pass	

Deviations From Test Standards

None

Approved By:

Kyle Holgate, Operations Manager

Product compliance is the responsibility of the client; therefore, the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test. This report reflects only those tests from the referenced standards shown in the certificate of test. It does not include inspection or verification of labels, identification, marking or user information.

REVISION HISTORY

Revision Number	Description	Date	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS

2017.6.12

United States

FCC - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

A2LA - Accredited by A2LA to ISO / IEC 17065 as a product certifier. This allows Element to certify transmitters to FCC and IC specifications.

NVLAP - Each laboratory is accredited by NVLAP to ISO 17025

Canada

ISED - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB). Certification chambers and Open Area Test Sites are filed with ISED.

European Union

European Commission – Within Element, we have a EU Notified Body validated for the EMCD and RED Directives.

Australia/New Zealand

ACMA - Recognized by ACMA as a CAB for the acceptance of test data.

Korea

MSIP / RRA - Recognized by KCC's RRA as a CAB for the acceptance of test data.

Japan

VCCI - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

Taiwan

BSMI – Recognized by BSMI as a CAB for the acceptance of test data.

NCC - Recognized by NCC as a CAB for the acceptance of test data.

Singapore

IDA – Recognized by IDA as a CAB for the acceptance of test data.

Israel

MOC – Recognized by MOC as a CAB for the acceptance of test data.

Hong Kong

OFCA – Recognized by OFCA as a CAB for the acceptance of test data.

Vietnam

MIC – Recognized by MIC as a CAB for the acceptance of test data.

SCOPE

For details on the Scopes of our Accreditations, please visit:
http://portlandcustomer.element.com/ts/scope/scope.htm
http://gsi.nist.gov/global/docs/cabs/designations.html

MEASUREMENT UNCERTAINTY

TMU.2015.07.10

Measurement Uncertainty

When a measurement is made, the result will be different from the true or theoretically correct value. The difference is the result of tolerances in the measurement system that cannot be completely eliminated. To the extent that technology allows us, it has been our aim to minimize this error. Measurement uncertainty is a statistical expression of measurement error qualified by a probability distribution.

A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable test description page. Our measurement data meets or exceeds the measurement uncertainty requirements of the applicable specification; therefore, the test data can be compared directly to the specification limit to determine compliance. The calculations for estimating measurement uncertainty are based upon ETSI TR 100 028 (or CISPR 16-4-2 as applicable), and are available upon request.

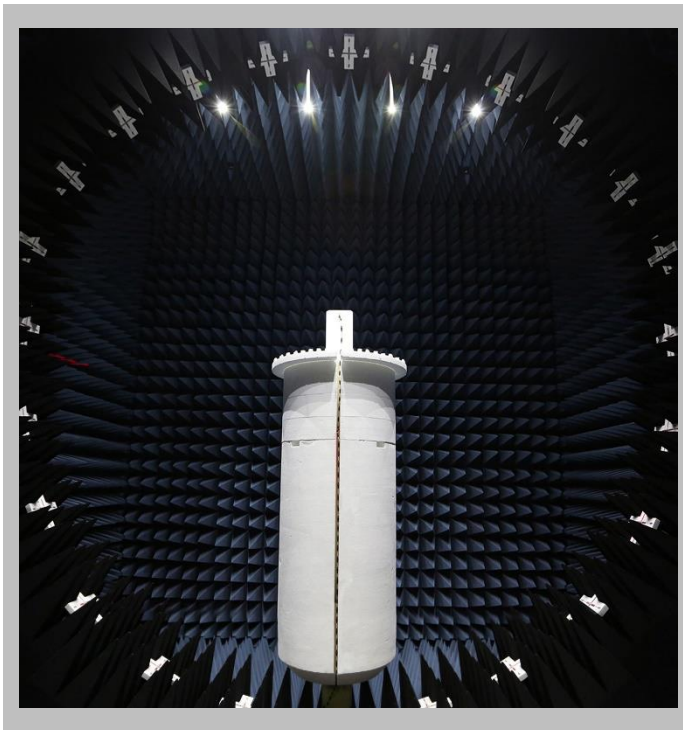
The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

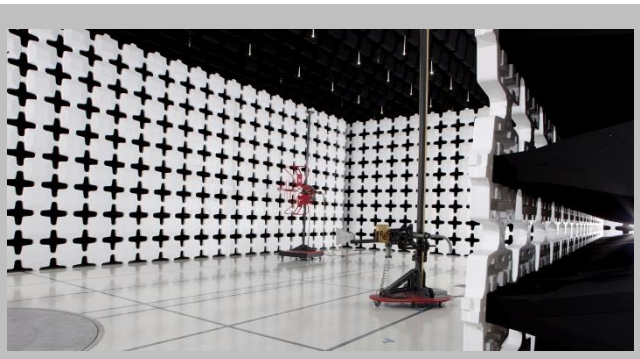
Test	+ MU	- MU
Frequency Accuracy (Hz)	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	0.3 dB	-0.3 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.2 dB	-5.2 dB
AC Powerline Conducted Emissions (dB)	2.4 dB	-2.4 dB

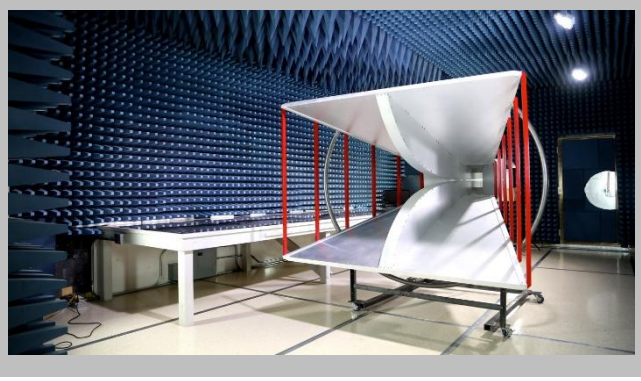
FACILITIES

2017.9.15

California	Minnesota	New York	Oregon	Texas	Washington
Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Labs MN01-08, MN10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	Labs NY01-04 4939 Jordan Rd. Elbridge, NY 13060 (315) 554-8214	Labs EV01-12 22975 NW Evergreen Pkwy Hillsboro, OR 97124 (503) 844-4066	Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Labs NC01-05 19201 120th Ave NE Bothell, WA 98011 (425)984-6600
NVLAP					
NVLAP Lab Code: 200676-0	NVLAP Lab Code: 200881-0	NVLAP Lab Code: 200761-0	NVLAP Lab Code: 200630-0	NVLAP Lab Code:201049-0	NVLAP Lab Code: 200629-0
Innovation, Science and Economic Development Canada					
2834B-1, 2834B-3	2834E-1, 2834E-3	N/A	2834D-1, 2834D-*2*	2834G-1	2834F-1
BSMI					
SL2-IN-E-1154R	SL2-IN-E-1152R	N/A	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI					
A-0029	A-0109	N/A	A-0108	A-0201	A-0110
Recognized Phase I CAB for ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA					
US0158	US0175	N/A	US0017	US0191	US0157

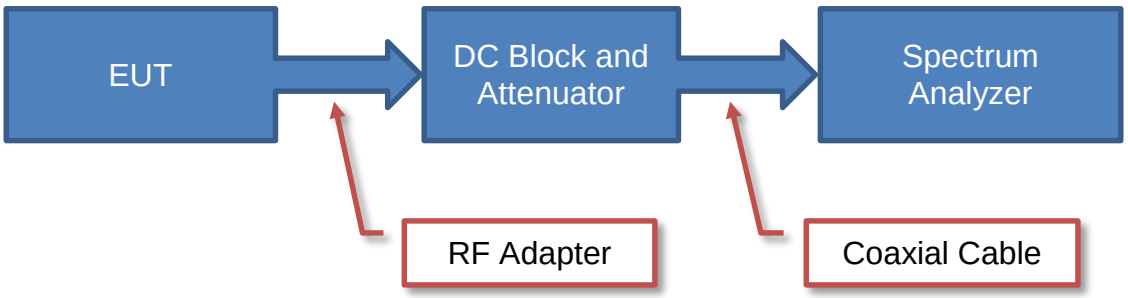




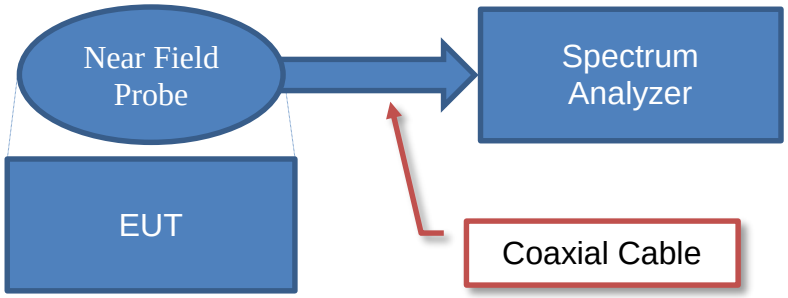


Test Setup Block Diagrams

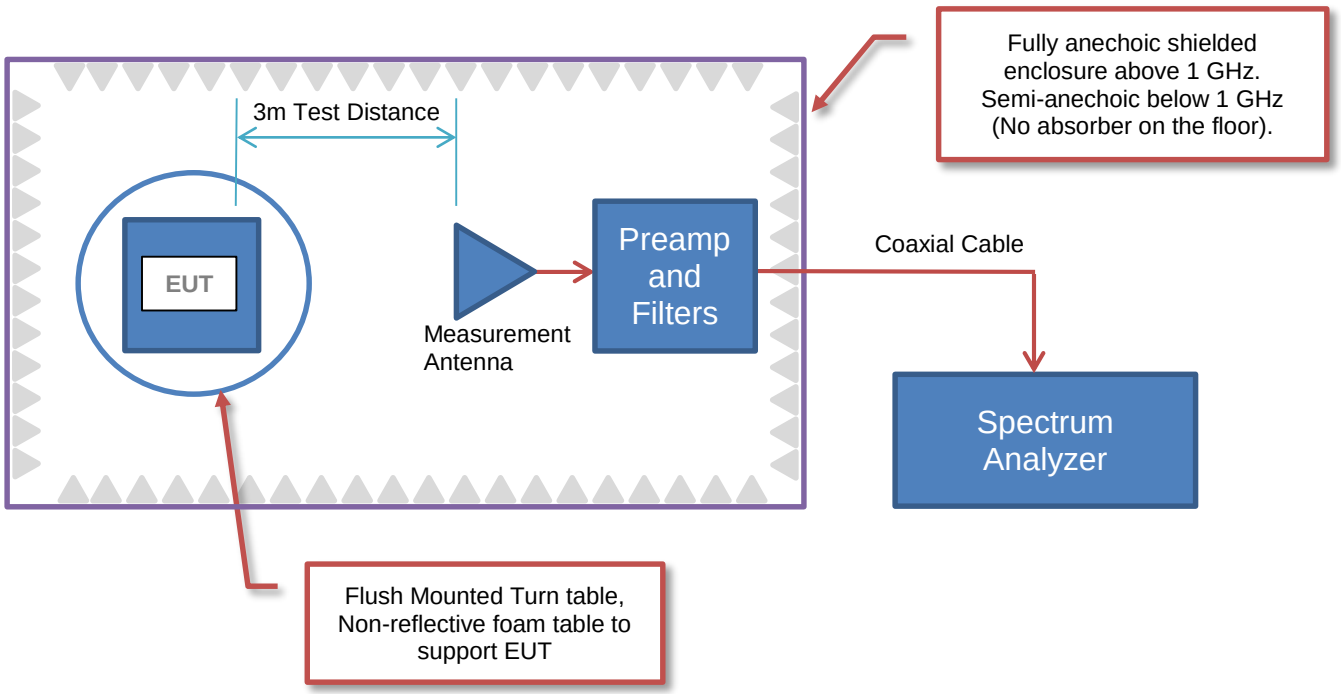
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions



PRODUCT DESCRIPTION

2017-1-25

Client and Equipment Under Test (EUT) Information

Company Name:	3D Systems Corporation
Address:	26600 SW Parkway
City, State, Zip:	Wilsonville, OR 97070-1000
Test Requested By:	Ali Elmi
Model:	Mercury RFID module
First Date of Test:	November 13, 2017
Last Date of Test:	November 20, 2017
Receipt Date of Samples:	November 13, 2017
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
13.56 MHz RFID radio module for use in 3D printers.

Testing Objective:
To demonstrate compliance of the 13.56 MHz RFID radio to FCC 15.225 requirements.

CONFIGURATIONS

Configuration 3DSY0090- 1

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Mercury RFID Module	3D Systems Corporation	360425 Rev C	1

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Host (Includes CAN Master and DC Power Supply)	3D Systems Corporation	None	None

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
I/O Cable	Yes	1.2 m	No	RFID Module	Host (Includes CAN Master and DC Power Supply)

Configuration 3DSY0090- 2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Mercury RFID Module	3D Systems Corporation	360425 Rev C	2

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Host (Includes CAN Master and DC Power Supply)	3D Systems Corporation	None	None
50 Ohm Terminator	Tektronix	011-0049-01	None

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
I/O Cable	Yes	1.2 m	No	RFID Module	Host (Includes CAN Master and DC Power Supply)
BNC to SMB	Yes	0.9 m	No	RFID Module	50 Ohm Terminator

MODIFICATIONS

2017-1-25

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	11/13/2017	Field Strength of Fundamental	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	11/13/2017	Field Strength of Spurious Emissions Less than 30 MHz	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
3	11/14/2017	Frequency Stability	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
4	11/14/2017	Field Strength of Spurious Emissions Greater than 30 MHz	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
5	11/20/2017	Powerline Conducted Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

POWERLINE CONDUCTED EMISSIONS

WTD.2017.07.11.1

TEST DESCRIPTION

The EUT will be powered either directly or indirectly from the AC power line. Therefore, conducted emissions measurements were made on the AC input of the EUT, or on the AC input of the device used to power the EUT.

The EUT was transmitting at its maximum data rate. For each mode, the spectrum was scanned from 150 kHz to 30 MHz. The test setup and procedures were in accordance with ANSI C63.10.

In the event that the operating frequency of 13.56 MHz is causing the product to fail the FCC 15.207 limits, the following guidance can be used:

In the FCC-TCBC Conference Call Meeting Minutes from April 12, 2005, the FCC stated:

> "We are willing to accept measurements on a 13.56 MHz transmitter done with a dummy load under the following conditions. First, perform the AC line conducted tests with the antenna attached to make sure the device complies with the 15.207 limits outside the transmitter's fundamental emission band, and then retest with a dummy load to make sure the device complies with the 15.207 limits inside the transmitter's fundamental emission band. For the second portion of these tests, only the fundamental emission band of the transmitter needs to be retested."

This procedure was followed for the AC powerline conducted emissions testing documented on the following pages.

Per the FCC Guidance, the FCC will accept measurements on a 13.56 MHz transmitter done with a dummy load under the following conditions. (1) First, perform the AC line conducted tests with the antenna attached to make sure the device complies with the 15.207 limits outside the transmitter's fundamental emission band, and then retest with a dummy load to make sure the device complies with the 15.207 limits inside the transmitter's fundamental emission band. (2) For the second portion of these tests, only the fundamental emission band of the transmitter needs to be retested.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Receiver	Rohde & Schwarz	ESCI	ARH	3/27/2017	3/27/2018
Cable - Conducted Cable Assembly	Element	EVG, HHD, RKA	EVGA	4/13/2017	4/13/2018
LISN	Solar Electronics	9252-50-R-24-BNC	LIP	10/4/2016	10/4/2018

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	2.4 dB	-2.4 dB

CONFIGURATIONS INVESTIGATED

3DSY0090-1
3DSY0090-2

MODES INVESTIGATED

RFID, Continuous Tx, 13.56 MHz

POWERLINE CONDUCTED EMISSIONS

EUT:	Mercury RFID module	Work Order:	3DSY0090
Serial Number:	1	Date:	11/20/2017
Customer:	3D Systems Corporation	Temperature:	22.4°C
Attendees:	Ali Elmi	Relative Humidity:	46%
Customer Project:	None	Bar. Pressure:	1011 mb
Tested By:	Jeff Alcoke	Job Site:	EV07
Power:	24 VDC	Configuration:	3DSY0090-1

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2017	ANSI C63.10:2013

TEST PARAMETERS

Run #:	3	Line:	High Line	Add. Ext. Attenuation (dB):	0

COMMENTS

None

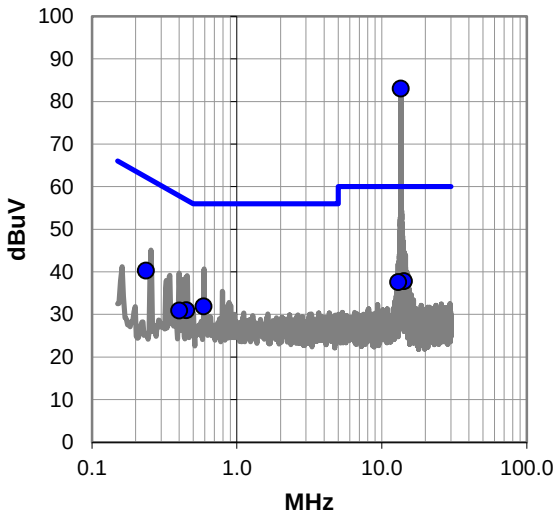
EUT OPERATING MODES

RFID, Continuous Tx, 13.56 MHz

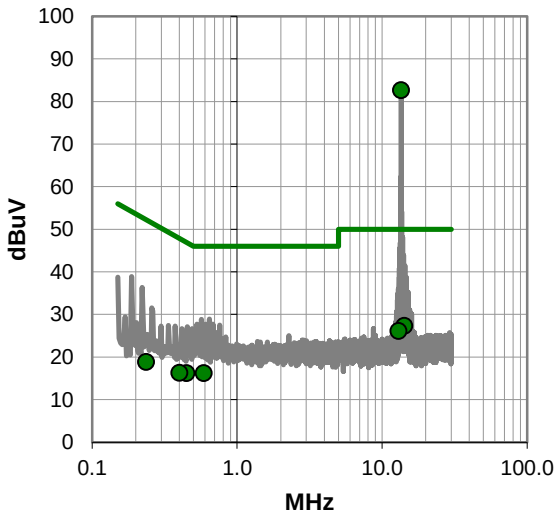
DEVIATIONS FROM TEST STANDARD

None

Quasi Peak Data - vs - Quasi Peak Limit



Average Data - vs - Average Limit



POWERLINE CONDUCTED EMISSIONS

WTD.2017.07.11.1

RESULTS - Run #3

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
13.560	62.8	20.2	83.0	60.0	23.0
0.235	20.7	19.6	40.3	62.3	-22.0
14.208	17.6	20.2	37.8	60.0	-22.2
12.992	17.4	20.2	37.6	60.0	-22.4
0.588	12.4	19.5	31.9	56.0	-24.1
0.448	11.5	19.5	31.0	56.9	-25.9
0.400	11.4	19.5	30.9	57.9	-27.0

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
13.560	62.4	20.2	82.6	50.0	32.6
14.208	7.1	20.2	27.3	50.0	-22.7
12.992	5.9	20.2	26.1	50.0	-23.9
0.588	-3.3	19.5	16.2	46.0	-29.8
0.448	-3.3	19.5	16.2	46.9	-30.7
0.400	-3.2	19.5	16.3	47.9	-31.6
0.235	-0.8	19.6	18.8	52.3	-33.5

CONCLUSION

Fail

Tested By

POWERLINE CONDUCTED EMISSIONS

WTD.2017.07.11.1

EUT:	Mercury RFID module	Work Order:	3DSY0090
Serial Number:	1	Date:	11/20/2017
Customer:	3D Systems Corporation	Temperature:	22.4°C
Attendees:	Ali Elmi	Relative Humidity:	46%
Customer Project:	None	Bar. Pressure:	1011 mb
Tested By:	Jeff Alcoke	Job Site:	EV07
Power:	24 VDC	Configuration:	3DSY0090-1

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2017	ANSI C63.10:2013

TEST PARAMETERS

Run #:	4	Line:	Neutral	Add. Ext. Attenuation (dB):	0

COMMENTS

None

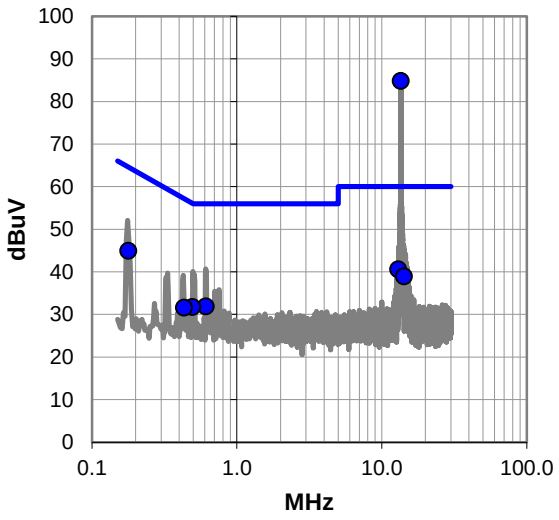
EUT OPERATING MODES

RFID, Continuous Tx, 13.56 MHz

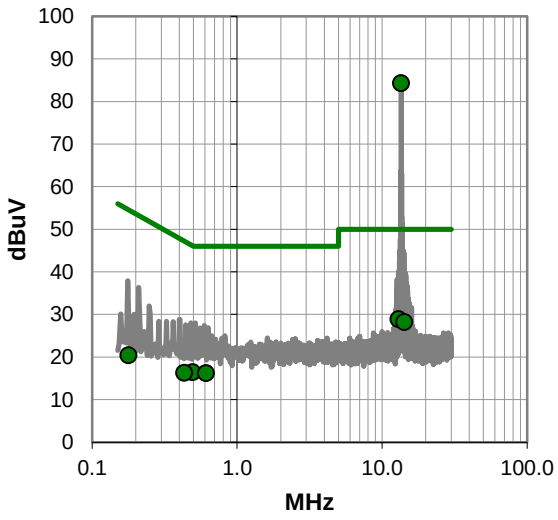
DEVIATIONS FROM TEST STANDARD

None

Quasi Peak Data - vs - Quasi Peak Limit



Average Data - vs - Average Limit



POWERLINE CONDUCTED EMISSIONS

WTD.2017.07.11.1

RESULTS - Run #4

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
13.560	64.6	20.2	84.8	60.0	24.8
12.992	20.4	20.2	40.6	60.0	-19.4
0.178	25.4	19.5	44.9	64.6	-19.7
14.208	18.7	20.2	38.9	60.0	-21.1
0.610	12.4	19.5	31.9	56.0	-24.1
0.492	12.2	19.5	31.7	56.1	-24.4
0.431	12.1	19.5	31.6	57.2	-25.6

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
13.560	64.1	20.2	84.3	50.0	34.3
12.992	8.7	20.2	28.9	50.0	-21.1
14.208	8.0	20.2	28.2	50.0	-21.8
0.492	-3.1	19.5	16.4	46.1	-29.7
0.610	-3.3	19.5	16.2	46.0	-29.8
0.431	-3.2	19.5	16.3	47.2	-30.9
0.178	0.9	19.5	20.4	54.6	-34.2

CONCLUSION

Fail

Tested By

POWERLINE CONDUCTED EMISSIONS

EUT:	Mercury RFID module	Work Order:	3DSY0090
Serial Number:	2	Date:	11/20/2017
Customer:	3D Systems Corporation	Temperature:	22.4°C
Attendees:	Ali Elmi	Relative Humidity:	46%
Customer Project:	None	Bar. Pressure:	1011 mb
Tested By:	Jeff Alcoke	Job Site:	EV07
Power:	24 VDC	Configuration:	3DSY0090-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2017	ANSI C63.10:2013

TEST PARAMETERS

Run #:	5	Line:	High Line	Add. Ext. Attenuation (dB):	0

COMMENTS

Antenna terminated with 50 ohm load

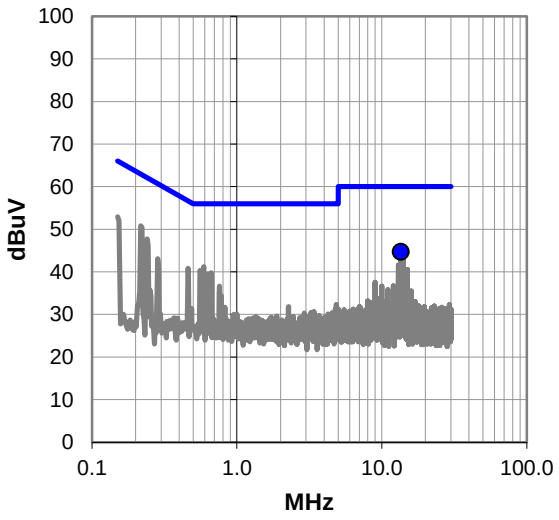
EUT OPERATING MODES

RFID, Continuous Tx, 13.56 MHz

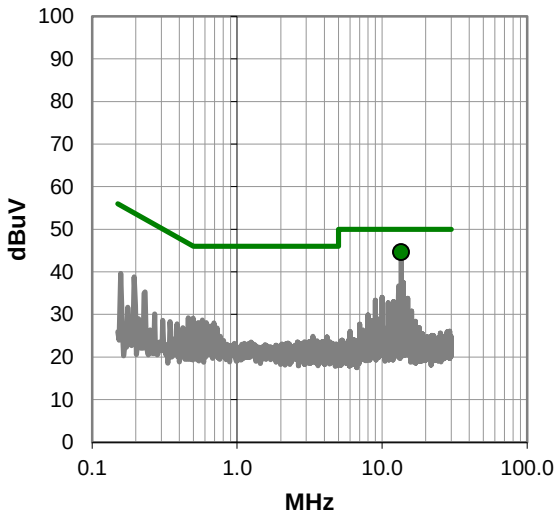
DEVIATIONS FROM TEST STANDARD

None

Quasi Peak Data - vs - Quasi Peak Limit



Average Data - vs - Average Limit



POWERLINE CONDUCTED EMISSIONS

WTD.2017.07.11.1

RESULTS - Run #5

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
13.561	24.5	20.2	44.7	60.0	-15.3

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
13.561	24.4	20.2	44.6	50.0	-5.4

CONCLUSION

Pass

Tested By

POWERLINE CONDUCTED EMISSIONS

EUT:	Mercury RFID module	Work Order:	3DSY0090
Serial Number:	2	Date:	11/20/2017
Customer:	3D Systems Corporation	Temperature:	22.4°C
Attendees:	Ali Elmi	Relative Humidity:	46%
Customer Project:	None	Bar. Pressure:	1011 mb
Tested By:	Jeff Alcoke	Job Site:	EV07
Power:	24 VDC	Configuration:	3DSY0090-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2017	ANSI C63.10:2013

TEST PARAMETERS

Run #:	6	Line:	Neutral	Add. Ext. Attenuation (dB):	0

COMMENTS

Antenna terminated with 50 ohm load

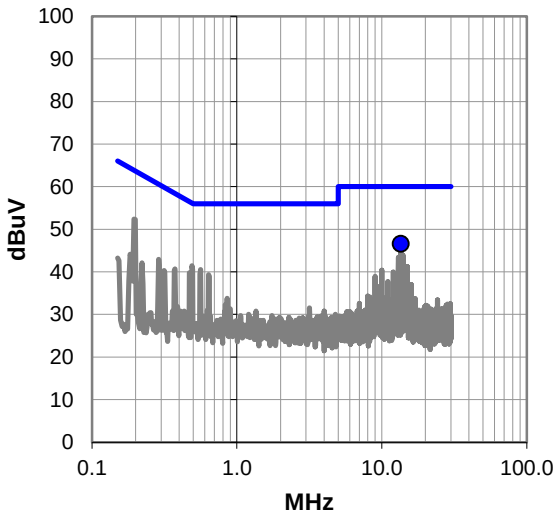
EUT OPERATING MODES

RFID, Continuous Tx, 13.56 MHz

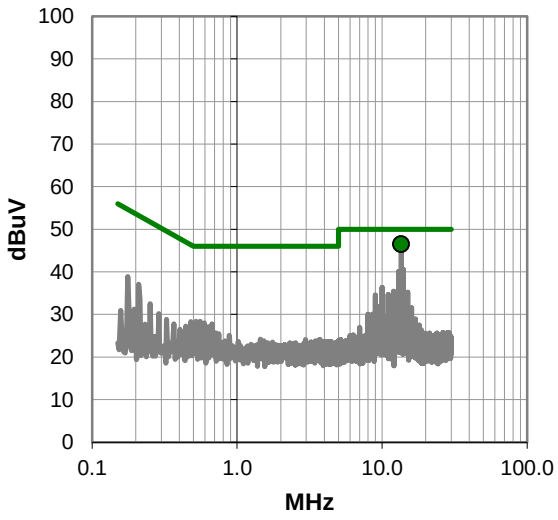
DEVIATIONS FROM TEST STANDARD

None

Quasi Peak Data - vs - Quasi Peak Limit



Average Data - vs - Average Limit



POWERLINE CONDUCTED EMISSIONS

WTD.2017.07.11.1

RESULTS - Run #6

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
13.560	26.4	20.2	46.6	60.0	-13.4

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
13.560	26.3	20.2	46.5	50.0	-3.5

CONCLUSION

Pass

Tested By

FIELD STRENGTH OF FUNDAMENTAL

PSA-ESCI 2017.06.01

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

RFID, Continuous Tx, 13.56 MHz

POWER SETTINGS INVESTIGATED

24 VDC

CONFIGURATIONS INVESTIGATED

3DSY0090 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	12.66 MHz	Stop Frequency	14.46 MHz

SAMPLE CALCULATIONS

Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor - Amplifier Gain + Distance Adjustment Factor + External Attenuation

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Antenna	EMCO	6502	AOA	7/6/2016	24 mo
Cable	Micro-Coax	UFD150A-1-0720-200200	EVH	5/30/2017	12 mo
Analyzer - Spectrum Analyzer	Agilent	E4443A	AFB	5/16/2017	12 mo

TEST DESCRIPTION

The antennas to be used with the EUT were tested. The EUT was continuously transmitting while set to the channel specified.

The fundamental carrier of the EUT was maximized by rotating the EUT on a turntable, adjusting the position of the EUT and EUT antenna in three orthogonal axis, and adjusting the measurement antenna height and polarization (per ANSI C63.10). A calibrated active loop antenna was used for this test in order to provide sufficient measurement sensitivity. The center of the loop antenna was maintained at 1m above the ground plane during the testing.

Measurements were made with the required detectors and annotated on the data for each individual point using the following annotation:

QP = Quasi-Peak Detector
PK = Peak Detector
AV = RMS Detector

As outlined in 15.209(e), 15.31(f)(2), and RSS-GEN, 6.4, measurements may be performed at a distance closer than what is specified with the limit. The limit at the specified distance is shown on the data sheet. Measurements are made at a closer distance and the data is adjusted using a distance correction factor of 40dB/decade for comparison to the limit.

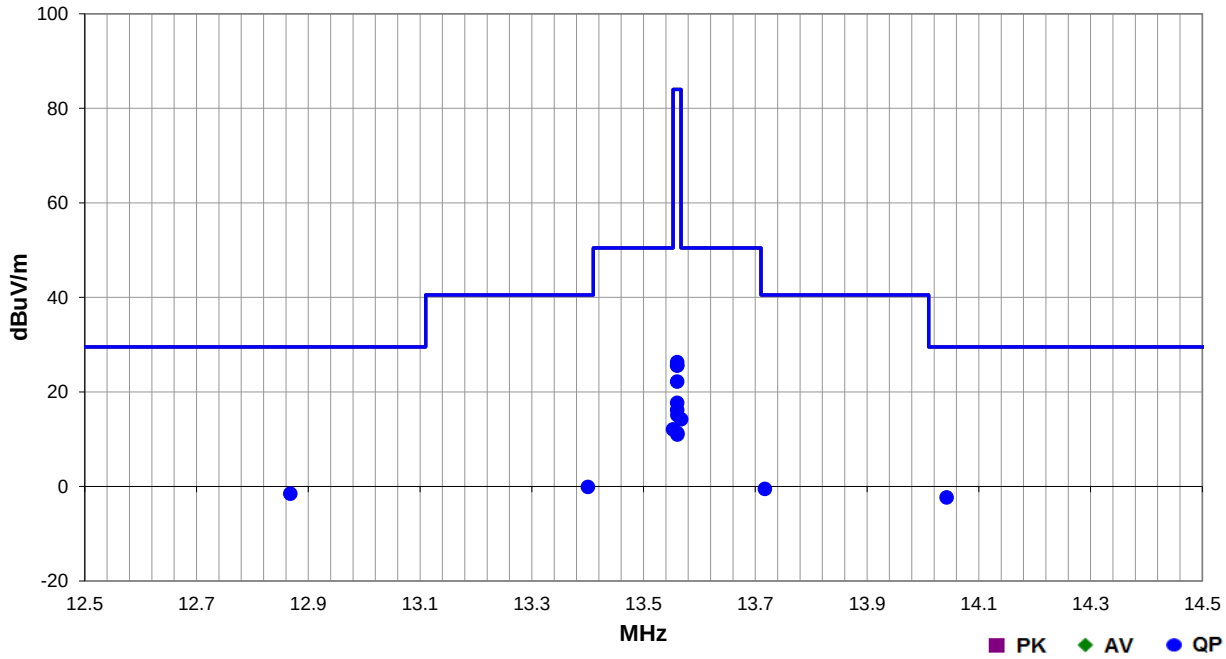
FIELD STRENGTH OF FUNDAMENTAL

EmiR5 2017.07.11 PSA-ESCI 2017.06.01

Work Order:	3DSY0090	**Date:**	11/13/17		
Project:	None	**Temperature:**	23.6 °C		
Job Site:	EV11	**Humidity:**	42.4% RH		
Serial Number:	1	**Barometric Pres.:**	1013 mbar	**Tested by:**	Jeff Alcoke
EUT:	Mercury RFID module				
Configuration:	1				
Customer:	3D Systems Corporation				
Attendees:	Ali Elmi				
EUT Power:	24 VDC				
Operating Mode:	RFID, Continuous Tx, 13.56 MHz				
Deviations:	None				
Comments:	See coments below for EUT orientation.				

Test Specifications	**Test Method**
FCC 15.225:2017	ANSI C63.10:2013

Run #	1	**Test Distance (m)**	10	**Antenna Height(s)**	1(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
12.868	6.5	11.1	1.0	109.0	10.0	0.0	Perp EUT	QP	-19.1	-1.5	29.5	-31.0	EUT Vertical
14.042	5.7	11.1	1.0	97.0	10.0	0.0	Perp EUT	QP	-19.1	-2.3	29.5	-31.8	EUT Vertical
13.567	22.2	11.1	1.0	160.0	10.0	0.0	Perp EUT	QP	-19.1	14.2	50.5	-36.3	EUT Vertical
13.553	20.1	11.1	1.0	161.0	10.0	0.0	Perp EUT	QP	-19.1	12.1	50.5	-38.4	EUT Vertical
13.401	7.9	11.1	1.0	163.0	10.0	0.0	Perp EUT	QP	-19.1	-0.1	40.5	-40.6	EUT Vertical
13.717	7.5	11.1	1.0	119.0	10.0	0.0	Perp EUT	QP	-19.1	-0.5	40.5	-41.0	EUT Vertical
13.560	34.3	11.1	1.0	196.0	10.0	0.0	Perp EUT	QP	-19.1	26.3	84.0	-57.7	EUT Vertical
13.560	33.6	11.1	1.0	95.0	10.0	0.0	Perp EUT	QP	-19.1	25.6	84.0	-58.4	EUT on Side
13.560	33.6	11.1	1.0	92.0	10.0	0.0	Par GND	QP	-19.1	25.6	84.0	-58.4	EUT on Side
13.560	30.2	11.1	1.0	31.0	10.0	0.0	Perp EUT	QP	-19.1	22.2	84.0	-61.8	EUT Horizontal
13.560	25.7	11.1	1.0	273.0	10.0	0.0	Par EUT	QP	-19.1	17.7	84.0	-66.3	EUT Vertical
13.560	24.2	11.1	1.0	175.0	10.0	0.0	Par EUT	QP	-19.1	16.2	84.0	-67.8	EUT on Side
13.560	23.1	11.1	1.0	217.0	10.0	0.0	Par GND	QP	-19.1	15.1	84.0	-68.9	EUT Vertical
13.560	19.3	11.1	1.0	318.0	10.0	0.0	Par GND	QP	-19.1	11.3	84.0	-72.7	EUT Horizontal
13.560	19.0	11.1	1.0	172.0	10.0	0.0	Par EUT	QP	-19.1	11.0	84.0	-73.0	EUT Horizontal

FIELD STRENGTH OF SPURIOUS EMISSIONS LESS THAN 30 MHZ

PSA-ESCI 2017.06.01

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

RFID, Continuous Tx, 13.56 MHz

POWER SETTINGS INVESTIGATED

24 VDC

CONFIGURATIONS INVESTIGATED

3DSY0090 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	9 kHz	Stop Frequency	30 MHz

SAMPLE CALCULATIONS

Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor - Amplifier Gain + Distance Adjustment Factor + External Attenuation

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Antenna	EMCO	6502	AOA	7/6/2016	24 mo
Cable	None	10m Test Distance Cable	EVL	4/17/2017	12 mo
Analyzer - Spectrum Analyzer	Agilent	E4443A	AFB	5/16/2017	12 mo

TEST DESCRIPTION

The antennas to be used with the EUT were tested. The EUT was continuously transmitting while set to the channel specified.

For each configuration, the spectrum was scanned throughout the specified range as part of the exploratory investigation of the emissions. These “pre-scans” are not included in the report. Final measurements on individual emissions were then made and included in this test report.

The individual emissions from the EUT were maximized by rotating the EUT on a turntable, adjusting the position of the EUT and EUT antenna in three orthogonal axis if required, and adjusting the measurement antenna height and polarization (per ANSI C63.10). An active loop antenna was used for this test in order to provide sufficient measurement sensitivity.

Measurements were made with the required detectors and annotated on the data for each individual point using the following annotation:

QP = Quasi-Peak Detector
PK = Peak Detector
AV = RMS Detector

If there are no detectable emissions above the noise floor, the data included may show noise floor measurements for reference only.

Measurements at the edges of the allowable band may be presented in an alternative method as provided for in the ANSI C63.10 Marker-Delta method. This method involves performing an in-band fundamental measurement followed by a screen capture of the fundamental and out-of-band emission using reduced measurement instrumentation bandwidths. The amplitude delta measured on this screen capture is applied to the fundamental emission value to show the out-of-band emission level as applied to the limit.

As outlined in 15.209(e), 15.31(f)(2), and RSS-GEN, 6.4, measurements may be performed at a distance closer than what is specified with the limit. The limit at the specified distance is shown on the data sheet. Measurements are made at a closer distance and the data is adjusted using a distance correction factor of 40dB/decade for comparison to the limit.

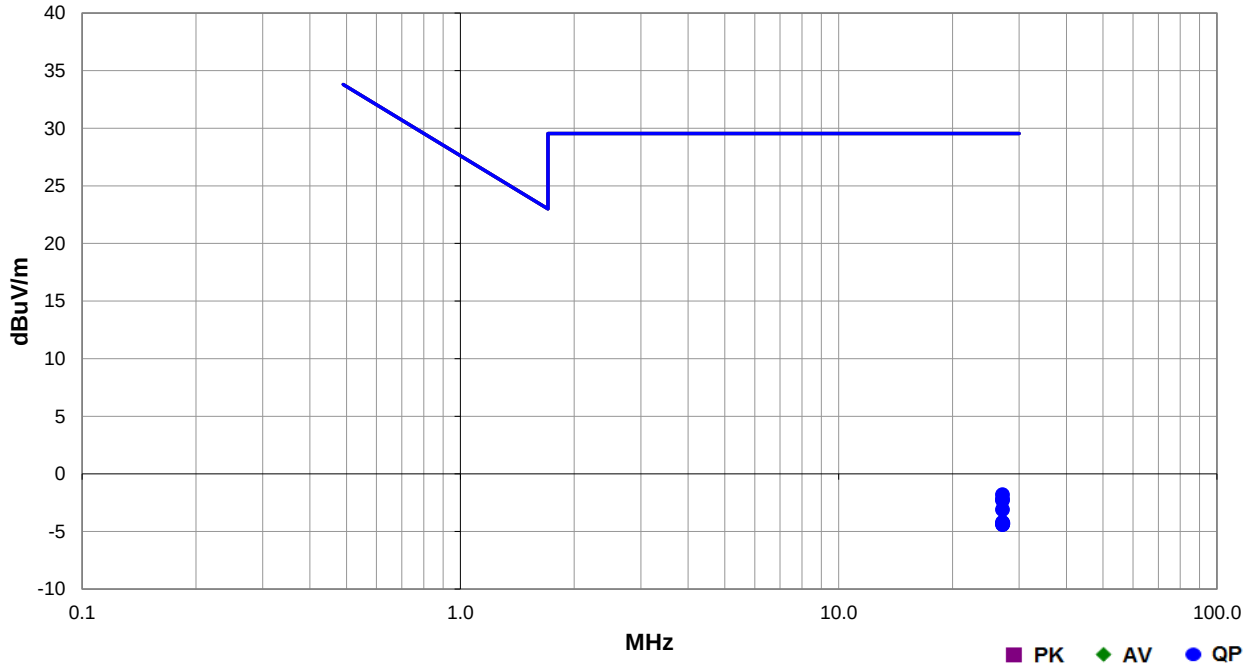
FIELD STRENGTH OF SPURIOUS EMISSIONS LESS THAN 30 MHZ

EmiR5 2017.07.11 PSA-ESCI 2017.06.01

Work Order:	3DSY0090	**Date:**	11/13/17		
Project:	None	**Temperature:**	23.6 °C		
Job Site:	EV11	**Humidity:**	42.4% RH		
Serial Number:	1	**Barometric Pres.:**	1013 mbar	**Tested by:**	Jeff Alcoke
EUT:	Mercury RFID module				
Configuration:	1				
Customer:	3D Systems Corporation				
Attendees:	Ali Elmi				
EUT Power:	24 VDC				
Operating Mode:	RFID, Continuous Tx, 13.56 MHz				
Deviations:	None				
Comments:	See comments below for EUT orientation				

Test Specifications	**Test Method**
FCC 15.225:2017	ANSI C63.10:2013

Run #	0	**Test Distance (m)**	10	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
27.122	8.0	9.3	1.0	32.0	10.0	0.0	Perp EUT	QP	-19.1	-1.8	29.5	-31.3	EUT Vertical
27.120	7.6	9.3	1.0	302.0	10.0	0.0	Perp EUT	QP	-19.1	-2.2	29.5	-31.7	EUT on Side
27.121	7.5	9.3	1.0	254.0	10.0	0.0	Par GND	QP	-19.1	-2.3	29.5	-31.8	EUT on Side
27.121	6.7	9.3	1.0	284.0	10.0	0.0	Perp EUT	QP	-19.1	-3.1	29.5	-32.6	EUT Horizontal
27.118	5.6	9.3	1.0	354.0	10.0	0.0	Par GND	QP	-19.1	-4.2	29.5	-33.7	EUT Horizontal
27.160	5.5	9.3	1.0	229.0	10.0	0.0	Par GND	QP	-19.1	-4.3	29.5	-33.8	EUT Vertical
27.136	5.5	9.3	1.0	337.0	10.0	0.0	Par EUT	QP	-19.1	-4.3	29.5	-33.8	EUT on Side
27.119	5.4	9.3	1.0	107.0	10.0	0.0	Par EUT	QP	-19.1	-4.4	29.5	-33.9	EUT Horizontal
27.132	5.4	9.3	1.0	31.0	10.0	0.0	Par EUT	QP	-19.1	-4.4	29.5	-33.9	EUT Vertical

FIELD STRENGTH OF SPURIOUS EMISSIONS GREATER THAN 30 MHZ

PSA-ESCI 2017.06.01

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

RFID, Continuous Tx, 13.56 MHz

POWER SETTINGS INVESTIGATED

24 VDC

CONFIGURATIONS INVESTIGATED

3DSY0090 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	1000 MHz

SAMPLE CALCULATIONS

Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor - Amplifier Gain + Distance Adjustment Factor + External Attenuation

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Cable	N/A	Bilog Cables	EVA	2/6/2017	12 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AOL	2/6/2017	12 mo
Antenna - Biconilog	Teseq	CBL 6141B	AXR	6/30/2016	24 mo
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFN	4/13/2017	12 mo

TEST DESCRIPTION

The antennas to be used with the EUT were tested. The EUT was transmitting while set at the operating channel.

For each configuration, the spectrum was scanned throughout the specified range as part of the exploratory investigation of the emissions. These “pre-scans” are not included in the report. Final measurements on individual emissions were then made and included in this test report.

The individual emissions from the EUT were maximized by rotating the EUT on a turntable, adjusting the position of the EUT and EUT antenna in three orthogonal axis, and adjusting the measurement antenna height and polarization (per ANSI C63.10). A preamp and high pass filter (and notch filter) were used for this test in order to provide sufficient measurement sensitivity.

Measurements were made with the required detectors and annotated on the data for each individual point using the following annotation:

QP = Quasi-Peak Detector
PK = Peak Detector
AV = RMS Detector

Measurements were made to satisfy the specific requirements of the test specification for out of band emissions as well as the restricted band requirements.

If there are no detectable emissions above the noise floor, the data included may show noise floor measurements for reference only.

Measurements at the edges of the allowable band may be presented in an alternative method as provided for in the ANSI C63.10 Marker-Delta method. This method involves performing an in-band fundamental measurement followed by a screen capture of the fundamental and out-of-band emission using reduced measurement instrumentation bandwidths. The amplitude delta measured on this screen capture is applied to the fundamental emission value to show the out-of-band emission level as applied to the limit.

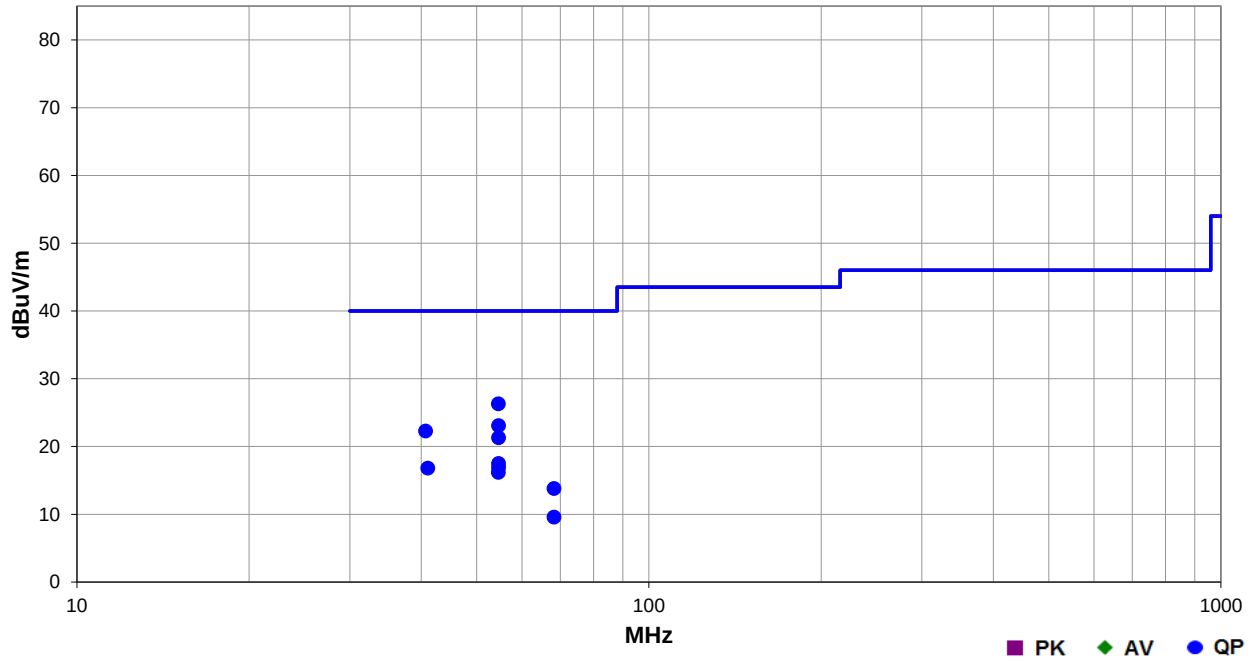
FIELD STRENGTH OF SPURIOUS EMISSIONS GREATER THAN 30 MHZ

EmiR5 2017.07.11 PSA-ESCI 2017.06.01

Work Order:	3DSY0090	**Date:**	11/14/17		
Project:	None	**Temperature:**	22.1 °C		
Job Site:	EV01	**Humidity:**	39.7% RH		
Serial Number:	1	**Barometric Pres.:**	1020 mbar	**Tested by:**	Jeff Alcoke
EUT:	Mercury RFID module				
Configuration:	1				
Customer:	3D Systems Corporation				
Attendees:	Ali Elmi				
EUT Power:	24 VDC				
Operating Mode:	RFID, Continuous Tx, 13.56 MHz				
Deviations:	None				
Comments:	See coments below for EUT orientation				

Test Specifications	**Test Method**
FCC 15.225:2017	ANSI C63.10:2013

Run #	3	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
54.562	31.4	-5.1	1.3	168.0	3.0	0.0	Vert	QP	0.0	26.3	40.0	-13.7	EUT Vertical
54.575	28.2	-5.1	1.3	209.0	3.0	0.0	Vert	QP	0.0	23.1	40.0	-16.9	EUT on Side
40.688	21.7	0.6	1.3	356.0	3.0	0.0	Vert	QP	0.0	22.3	40.0	-17.7	EUT Vertical
54.577	26.4	-5.1	1.1	226.0	3.0	0.0	Vert	QP	0.0	21.3	40.0	-18.7	EUT Horizontal
54.578	22.6	-5.1	1.0	36.0	3.0	0.0	Horz	QP	0.0	17.5	40.0	-22.5	EUT Vertical
54.565	22.0	-5.1	1.0	94.0	3.0	0.0	Horz	QP	0.0	16.9	40.0	-23.1	EUT on Side
41.038	16.4	0.4	4.0	310.0	3.0	0.0	Horz	QP	0.0	16.8	40.0	-23.2	EUT Vertical
54.562	21.3	-5.1	1.0	168.0	3.0	0.0	Horz	QP	0.0	16.2	40.0	-23.8	EUT Horizontal
68.213	22.1	-8.3	1.0	34.0	3.0	0.0	Vert	QP	0.0	13.8	40.0	-26.2	EUT Vertical
68.212	17.9	-8.3	1.0	147.0	3.0	0.0	Horz	QP	0.0	9.6	40.0	-30.4	EUT Vertical

FREQUENCY STABILITY

XMit 2017.09.21

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Chamber - Temperature/Humidity	Cincinnati Sub Zero (CSZ)	ZPH-8-2-SCT/AC	TBI	NCR	NCR
Probe - Near Field Set	EMCO	7405	IPD	NCR	NCR
Thermometer	Omega Engineering, Inc.	HH311	DUI	26-Jan-15	26-Jan-18
Power Supply - DC	Topward	TPS-2000	TPD	NCR	NCR
Meter - Multimeter	Tektronix	DMM912	MMH	17-Feb-16	17-Feb-19
Attenuator	Fairview Microwave	SA18N5WA-20	TYV	NCR	NCR
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFP	14-Aug-17	14-Aug-18

TEST DESCRIPTION

A near-field probe was placed near the transmitter. A low-loss coaxial cable was used to connect the near-field probe to the spectrum analyzer. The spectrum analyzer is equipped with a precision frequency reference that exceeds the stability requirement of the EUT.

Measurements were made on the single transmit frequency as called out on the data sheets. Testing was done while the EUT was continuously polling.

The primary supply voltage was varied from 85 % to 115% of the nominal voltage while at ambient temperature. Using a temperature chamber, the transmit frequency was recorded at the extremes of the specified temperature range of -20 ° to +50° C and at 10°C intervals.

The requirement of a frequency tolerance of ±0.01% is equivalent to 100 ppm
The formula to check for compliance is:

FREQUENCY STABILITY

XMit 2017.09.21

EUT:	Mercury RFID module			**Work Order:**	3DSY0090
Serial Number:	1			**Date:**	14-Nov-17
Customer:	3D Systems Corporation			**Temperature:**	21.9 °C
Attendees:	Ali Elmi			**Humidity:**	41.6% RH
Project:	None			**Barometric Pres.:**	1022 mbar
Tested by:	Jeff Alcoke	**Power:**	24 VDC	**Job Site:**	EV06

TEST SPECIFICATIONS	**Test Method**
FCC 15.225:2017	ANSI C63.10:2013

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

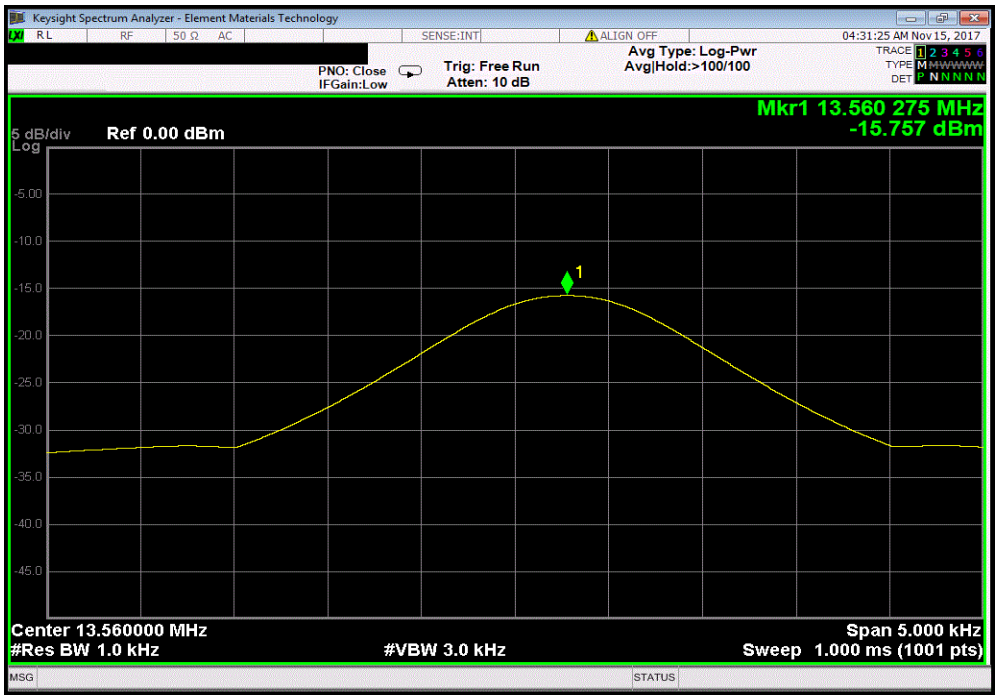
Configuration #	1	*Signature*

	Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
RFID, Continuous Tx, 13.56 MHz					
115% Voltage, 27.6 VDC, +20°C	13.560275	13.56	20.28	100	Pass
Nominal Voltage, 24.0 VDC, +20°C	13.560265	13.56	19.54	100	Pass
86% Voltage, 20.4 VDC, +20°C	13.560275	13.56	20.28	100	Pass
Nominal Voltage, 24.0 VDC, +50°C	13.560235	13.56	17.33	100	Pass
Nominal Voltage, 24.0 VDC, +40°C	13.560285	13.56	21.02	100	Pass
Nominal Voltage, 24.0 VDC, +30°C	13.560315	13.56	23.23	100	Pass
Nominal Voltage, 24.0 VDC, +20°C	13.560265	13.56	19.54	100	Pass
Nominal Voltage, 24.0 VDC, +10°C	13.560295	13.56	21.76	100	Pass
Nominal Voltage, 24.0 VDC, 0°C	13.560315	13.56	23.23	100	Pass
Nominal Voltage, 24.0 VDC, -10°C	13.560320	13.56	23.60	100	Pass
Nominal Voltage, 24.0 VDC, -20°C	13.560280	13.56	20.65	100	Pass

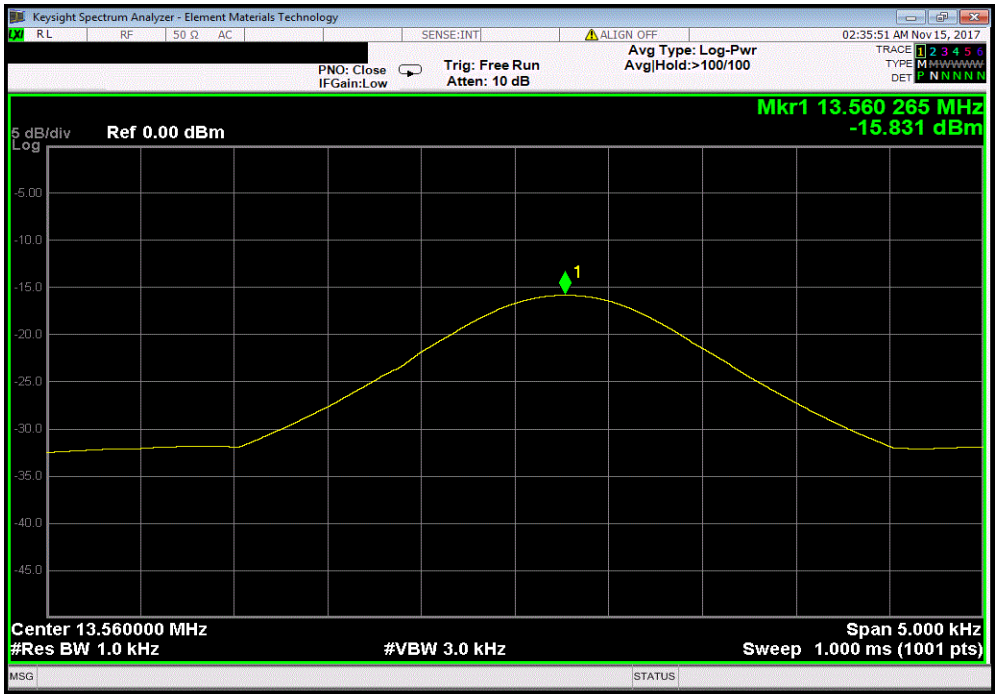
FREQUENCY STABILITY

XMit 2017.09.21

RFID, Continuous Tx, 13.56 MHz, 115% Voltage, 27.6 VDC, +20°C						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
		13.560275	13.56	20.3	100	Pass



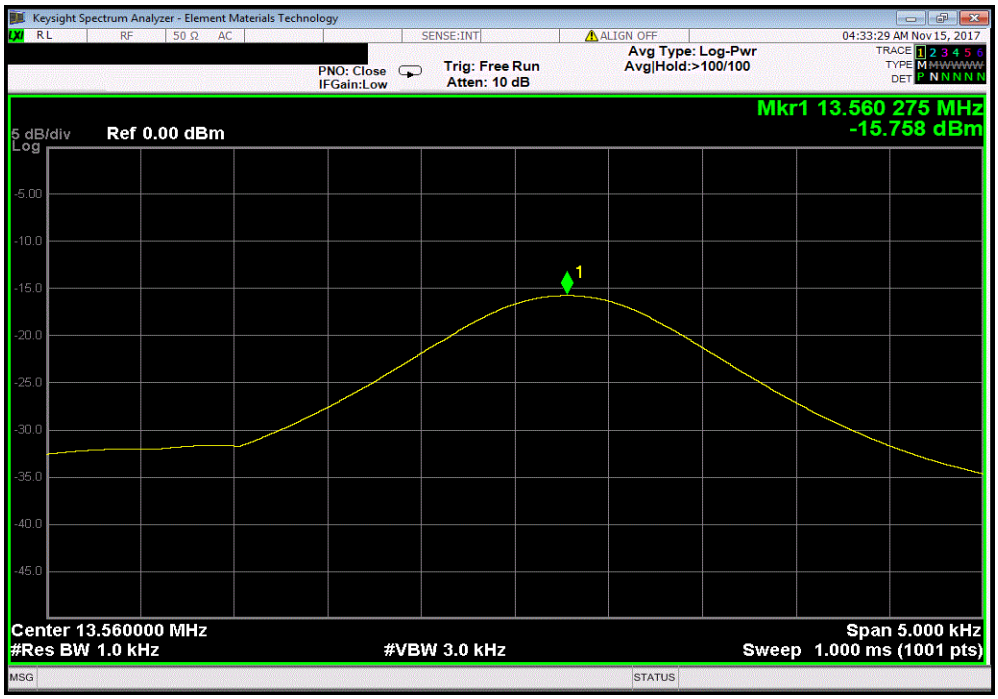
RFID, Continuous Tx, 13.56 MHz, Nominal Voltage, 24.0 VDC, +20°C						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
		13.560265	13.56	19.5	100	Pass



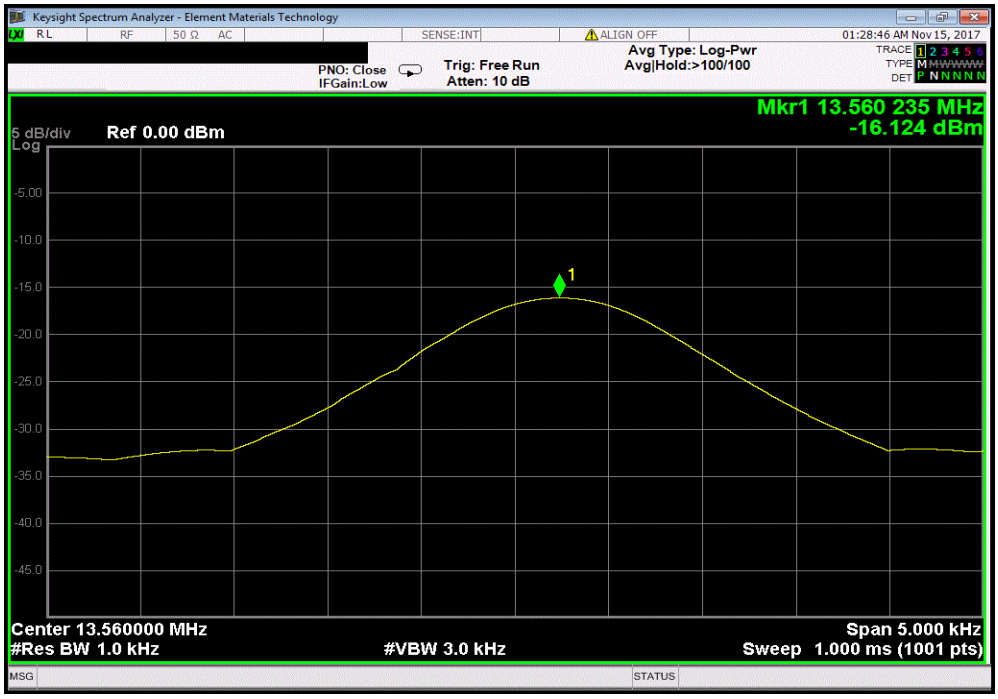
FREQUENCY STABILITY

XMit 2017.09.21

RFID, Continuous Tx, 13.56 MHz, 86% Voltage, 20.4 VDC, +20°C						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
		13.560275	13.56	20.3	100	Pass



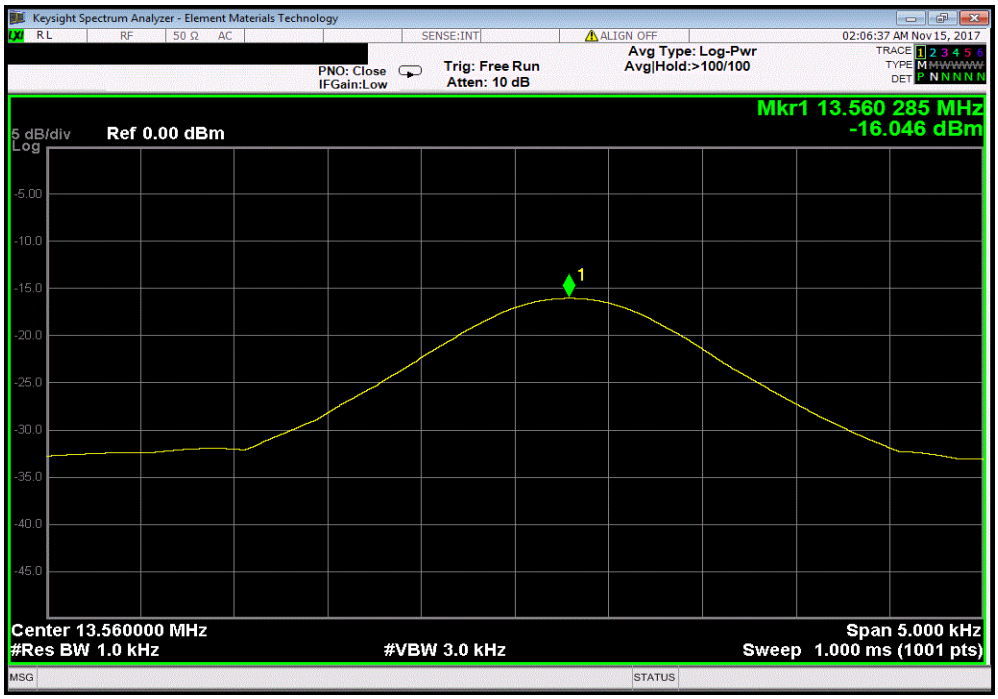
RFID, Continuous Tx, 13.56 MHz, Nominal Voltage, 24.0 VDC, +50°C						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
		13.560235	13.56	17.3	100	Pass



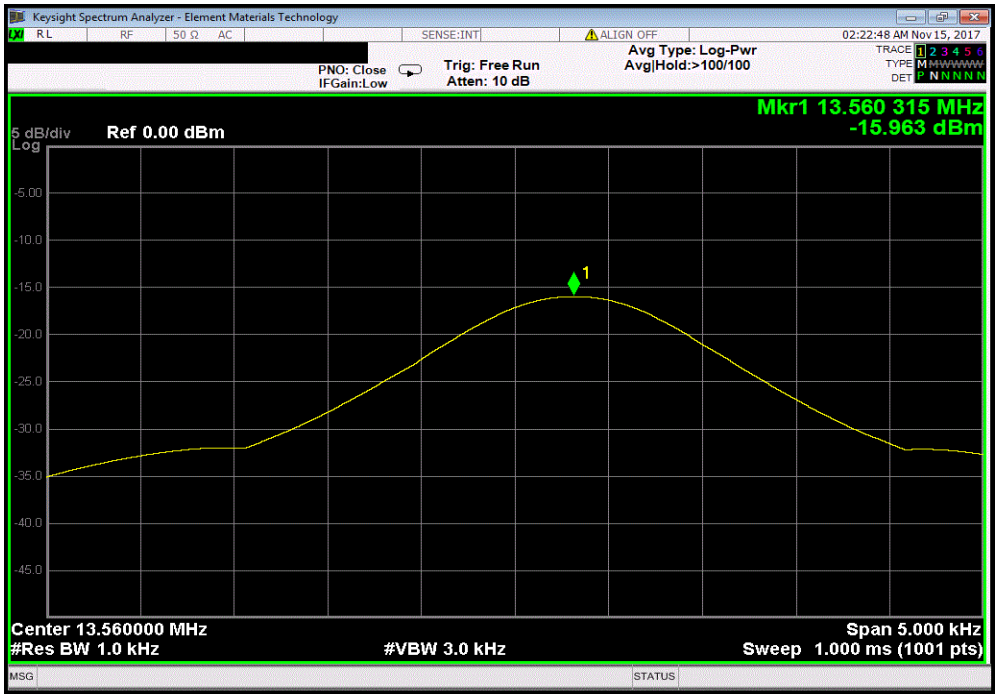
FREQUENCY STABILITY

XMit 2017.09.21

RFID, Continuous Tx, 13.56 MHz, Nominal Voltage, 24.0 VDC, +40°C						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
		13.560285	13.56	21.0	100	Pass



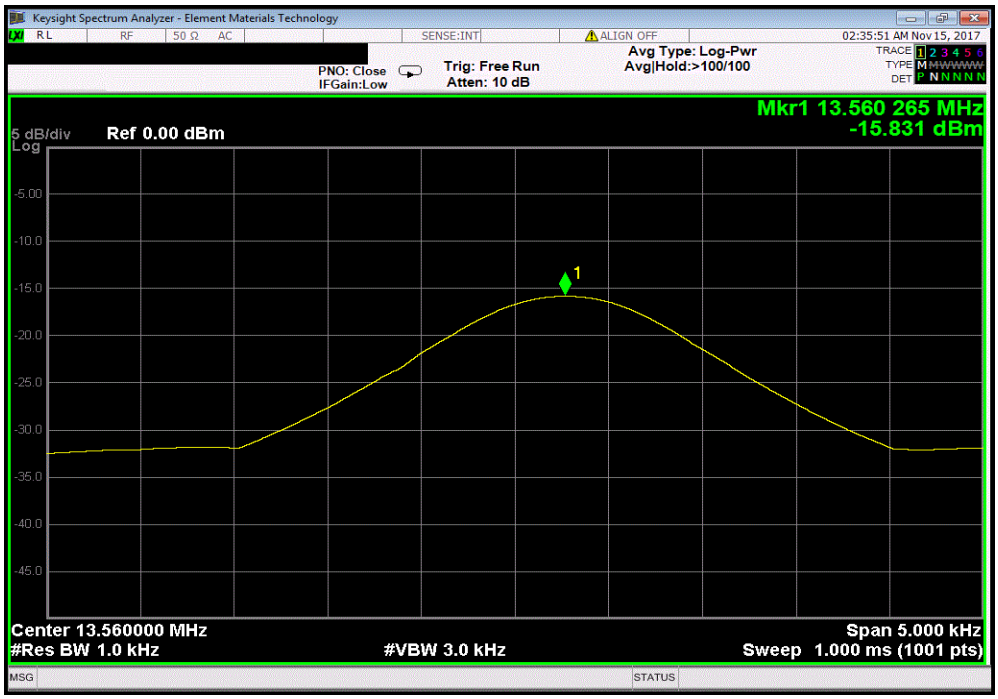
RFID, Continuous Tx, 13.56 MHz, Nominal Voltage, 24.0 VDC, +30°C						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
		13.560315	13.56	23.2	100	Pass



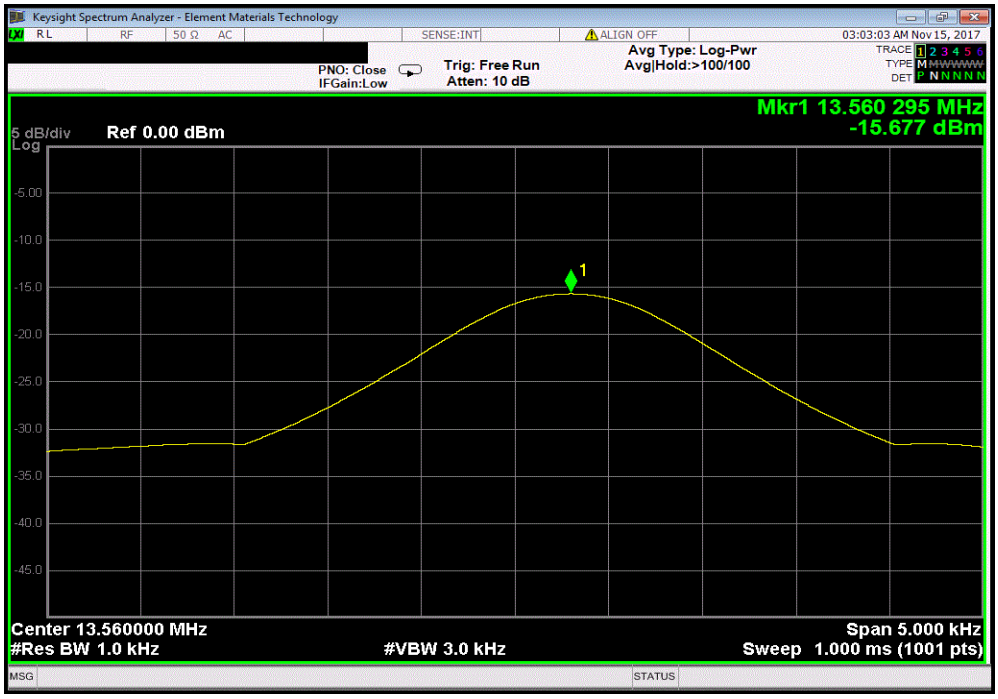
FREQUENCY STABILITY

XMit 2017.09.21

RFID, Continuous Tx, 13.56 MHz, Nominal Voltage, 24.0 VDC, +20°C						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
		13.560265	13.56	19.5	100	Pass



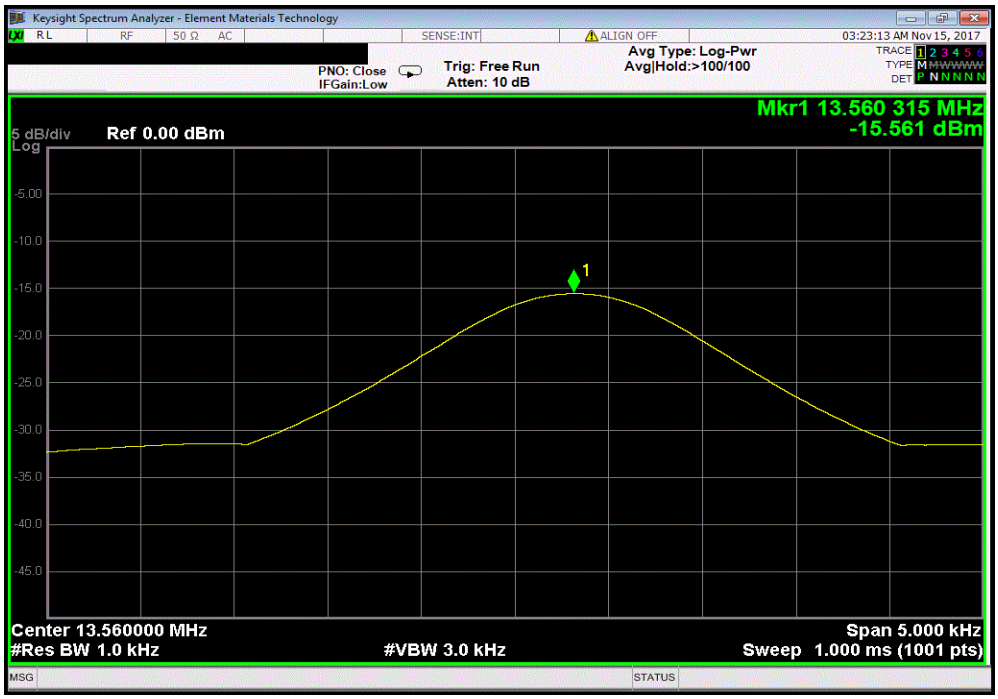
RFID, Continuous Tx, 13.56 MHz, Nominal Voltage, 24.0 VDC, +10°C						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
		13.560295	13.56	21.8	100	Pass



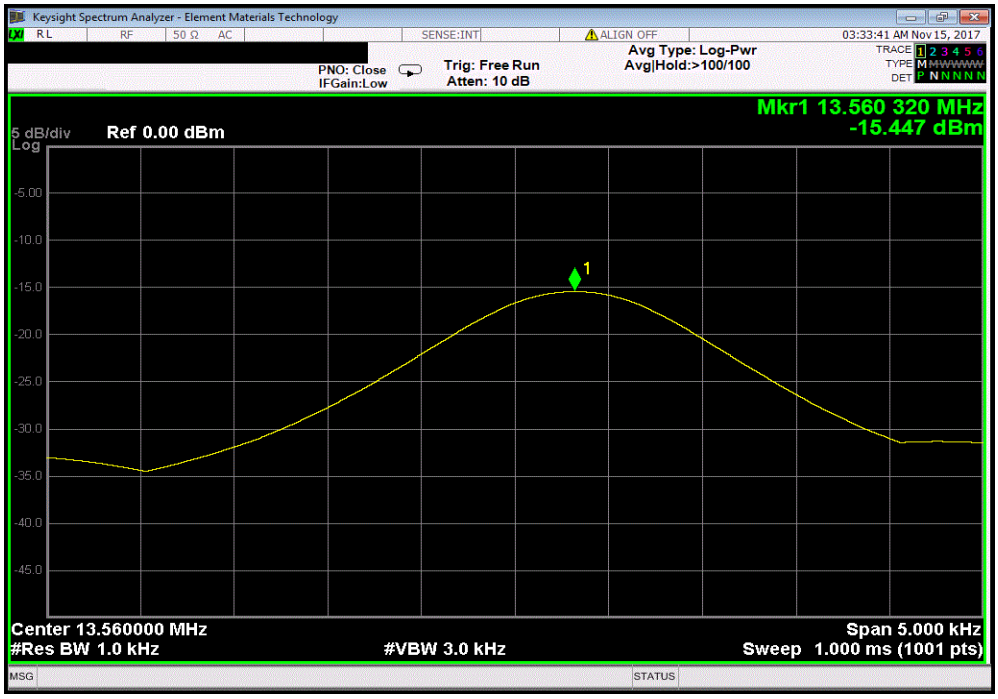
FREQUENCY STABILITY

XMit 2017.09.21

RFID, Continuous Tx, 13.56 MHz, Nominal Voltage, 24.0 VDC, 0°C						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
		13.560315	13.56	23.2	100	Pass



RFID, Continuous Tx, 13.56 MHz, Nominal Voltage, 24.0 VDC, -10°C						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
		13.56032	13.56	23.6	100	Pass



FREQUENCY STABILITY

XMit 2017.09.21

RFID, Continuous Tx, 13.56 MHz, Nominal Voltage, 24.0 VDC, -20°C						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Result
		13.560280	13.56	20.6	100	Pass