Cardiovascular Systems, Inc.

Exchangeable OAD

FCC 15.207:2018

FCC 15.225:2018

13.56 MHz Radio

Report # CSYS0026.2

NVLAP LAB CODE: 200881-0

CERTIFICATE OF TEST

Last Date of Test: March 29, 2018
Cardiovascular Systems, Inc.
Model: Exchangeable OAD

Radio Equipment Testing

Standards

Specification	Method
FCC 15.207:2018	ANSI C63.10:2013
FCC 15.225:2018	

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:

Matt Nuernberg, 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

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

MSIT / 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.

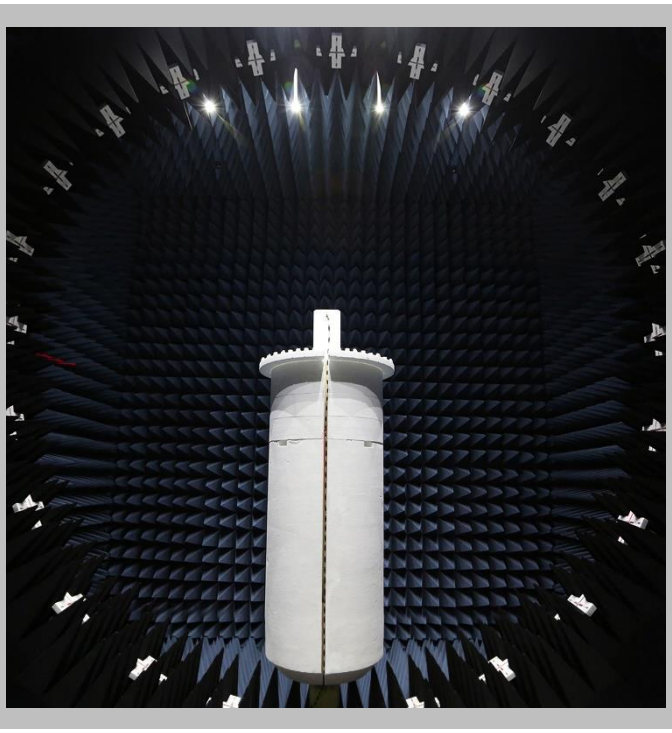
A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable 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.

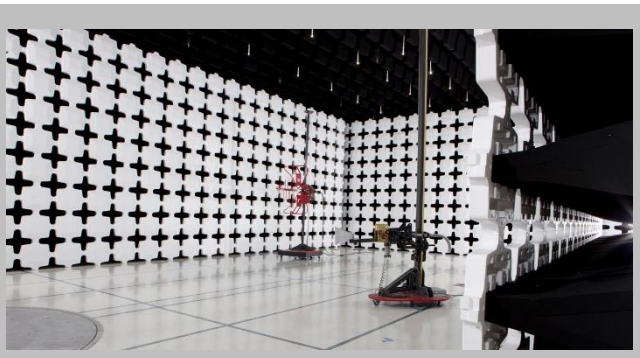
The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

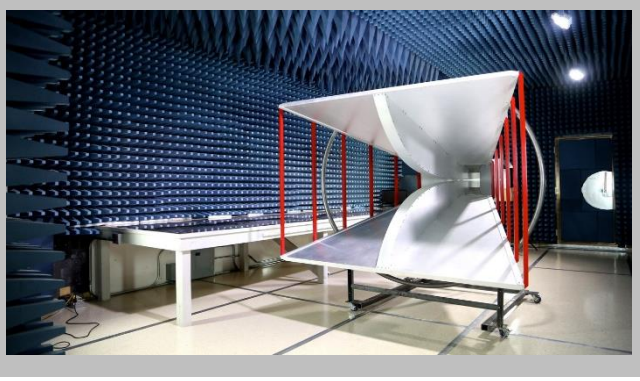
Test	+ MU	- MU
Frequency Accuracy (Hz)	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	0.3 dB	-0.3 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%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

FACILITIES

California	Minnesota	New York	Oregon	Texas	Washington
Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Labs MN01-10 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 6775 NE Evergreen Pkwy #400 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

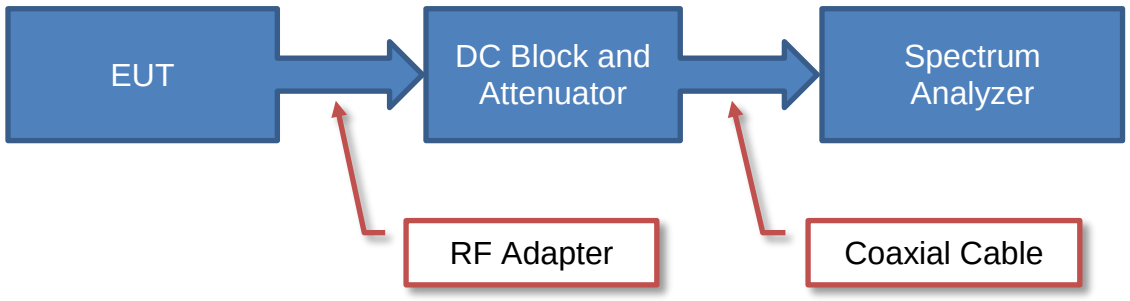




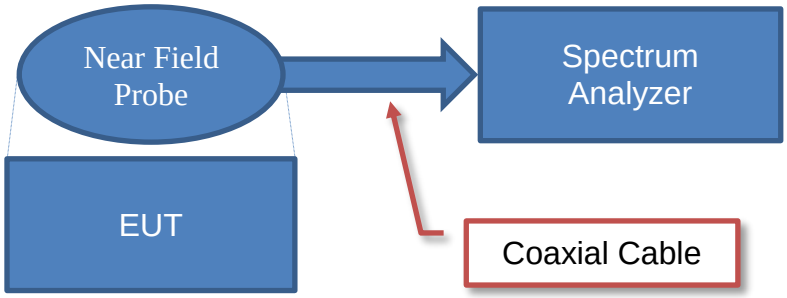


Test Setup Block Diagrams

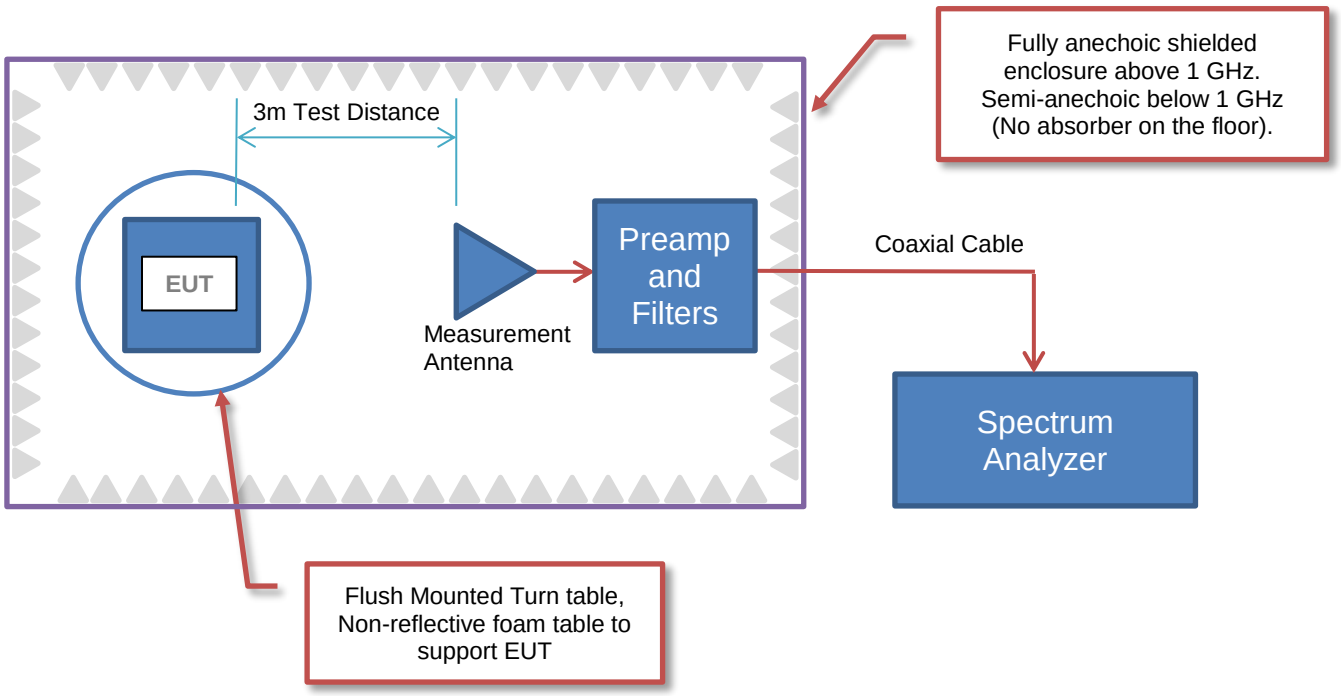
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions



PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	Cardiovascular Systems, Inc.
Address:	1225 Old Highway 8 NW
City, State, Zip:	St. Paul, MN 55112 No
Test Requested By:	Michael Welsch
Model:	Exchangeable OAD
First Date of Test:	March 26, 2018
Last Date of Test:	March 29, 2018
Receipt Date of Samples:	March 26, 2018
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
Medical device with 13.56 MHz RFID radio

Testing Objective:
To demonstrate compliance to FCC Part 15.225 specifications.

CONFIGURATIONS

Configuration CSYS0026- 1

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
OAS Pump	Cardiovascular Systems, Inc.	7-10037	184804
Handle/Cartridge Assembly, 2.00 Solid, 145cm	Cardiovascular Systems, Inc.	7-10030-04	220692

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Weight Sensor	Cardiovascular Systems, Inc.	60255-02	184804
Guide Wire	Cardiovascular Systems, Inc.	7-10026-01	166551

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
Weight Sensor Cable	No	0.5m	No	OAS Pump	Weight Sensor
Power Cable	No	6.1m	No	OAS Pump	AC Mains
Handle Assembly Cable	No	3.3m	No	OAS Pump	Handle/Cartridge Assembly

Configuration CSYS0026- 2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
OAS Pump	Cardiovascular Systems, Inc.	7-10037	184804
Handle/Cartridge Assembly, 2.00 Solid, 145cm	Cardiovascular Systems, Inc.	7-10030-04	220693

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Weight Sensor	Cardiovascular Systems, Inc.	60255-02	184804
Guide Wire	Cardiovascular Systems, Inc.	7-10026-01	166551

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
Weight Sensor Cable	No	0.5m	No	OAS Pump	Weight Sensor
Power Cable	No	6.1m	No	OAS Pump	AC Mains
Handle Assembly Cable	No	3.3m	No	OAS Pump	Handle/Cartridge Assembly

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	3/26/2018	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	3/26/2018	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	3/27/2018	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.
4	3/28/2018	Powerline Conducted Emissions	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	3/29/2018	Frequency Stability	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.2017.11.22.1

TEST DESCRIPTION

Using the mode of operation and configuration noted within this report, conducted emissions tests were performed. The frequency range investigated (scanned), is also noted in this report. Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Per the standard, an insulating material was also added to ground plane between the EUT's power and remote I/O cables. Equipment is tested with power cords that are normally used or that have electrical or shielding characteristics that are the same as those cords normally used. Typically those measurements are made using a LISN (Line Impedance Stabilization Network), the 50ohm measuring port is terminated by a 50ohm EMI meter or a 50ohm resistive load. All 50ohm measuring ports of the LISN are terminated by 50ohm. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Receiver	Rohde & Schwarz	ESR7	ARI	6/4/2017	6/4/2018
Cable - Conducted Cable Assembly	Northwest EMC	MNC, HGN, TYK	MNCA	3/14/2018	3/14/2019
LISN	Solar Electronics	9252-50-R-24-BNC	LIY	3/15/2018	3/15/2019

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	2.4 dB	-2.4 dB

CONFIGURATIONS INVESTIGATED

CSYS0026-2

MODES INVESTIGATED

Transmitting RFID, 13.56 MHz modulated

POWERLINE CONDUCTED EMISSIONS

WTD.2017.11.22.1

EUT:	Exchangeable OAD	Work Order:	CSYS0026
Serial Number:	220693	Date:	03/28/2018
Customer:	Cardiovascular Systems, Inc.	Temperature:	22.3°C
Attendees:	Michael Welsch	Relative Humidity:	25.6%
Customer Project:	None	Bar. Pressure:	1013 mb
Tested By:	Dustin Sparks	Job Site:	MN03
Power:	110VAC/60Hz	Configuration:	CSYS0026-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2018	ANSI C63.10:2013

TEST PARAMETERS

Run #:	12	Line:	Neutral	Add. Ext. Attenuation (dB):	0

COMMENTS

Using dummy load on antenna per FCC guidelines

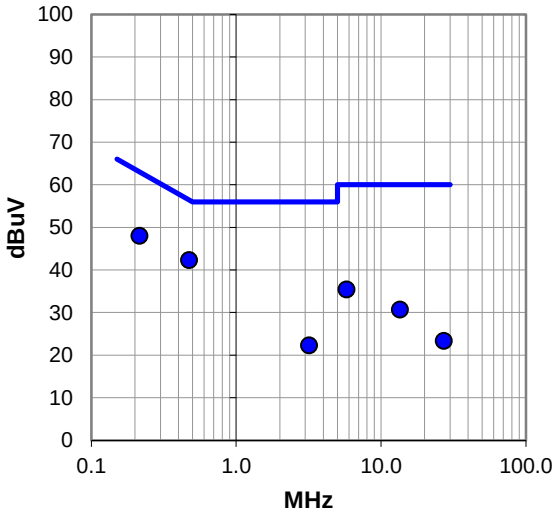
EUT OPERATING MODES

Transmitting RFID, 13.56 MHz modulated

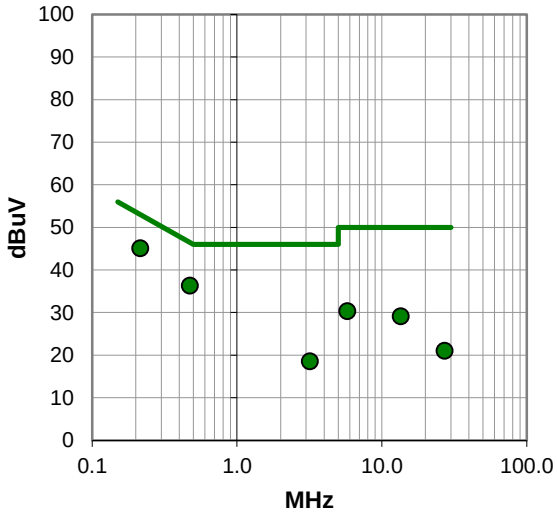
DEVIATIONS FROM TEST STANDARD

None

Quasi Peak Data - vs - Quasi Peak Limit



Average Data - vs - Average Limit



POWERLINE CONDUCTED EMISSIONS

WTD.2017.11.22.1

RESULTS - Run #12

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.473	21.9	20.4	42.3	56.5	-14.2
0.215	27.4	20.6	48.0	63.0	-15.0
5.785	14.6	20.8	35.4	60.0	-24.6
13.559	9.1	21.6	30.7	60.0	-29.3
3.188	1.7	20.6	22.3	56.0	-33.7
27.120	-0.3	23.6	23.3	60.0	-36.7

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.215	24.5	20.6	45.1	53.0	-7.9
0.473	15.9	20.4	36.3	46.5	-10.2
5.785	9.5	20.8	30.3	50.0	-19.7
13.559	7.5	21.6	29.1	50.0	-20.9
3.188	-2.1	20.6	18.5	46.0	-27.5
27.120	-2.6	23.6	21.0	50.0	-29.0

CONCLUSION

Pass

Tested By

POWERLINE CONDUCTED EMISSIONS

WTD.2017.11.22.1

EUT:	Exchangeable OAD	Work Order:	CSYS0026
Serial Number:	220693	Date:	03/28/2018
Customer:	Cardiovascular Systems, Inc.	Temperature:	22.3°C
Attendees:	Michael Welsch	Relative Humidity:	25.6%
Customer Project:	None	Bar. Pressure:	1013 mb
Tested By:	Dustin Sparks	Job Site:	MN03
Power:	110VAC/60Hz	Configuration:	CSYS0026-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2018	ANSI C63.10:2013

TEST PARAMETERS

Run #:	13	Line:	High Line	Add. Ext. Attenuation (dB):	0

COMMENTS

Using dummy load on antenna per FCC guidelines

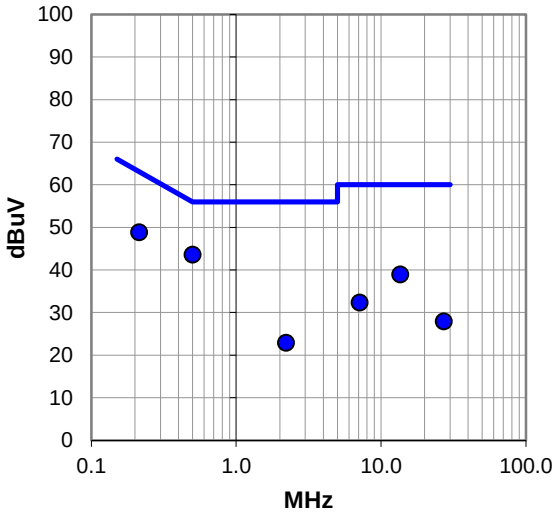
EUT OPERATING MODES

Transmitting RFID, 13.56 MHz modulated

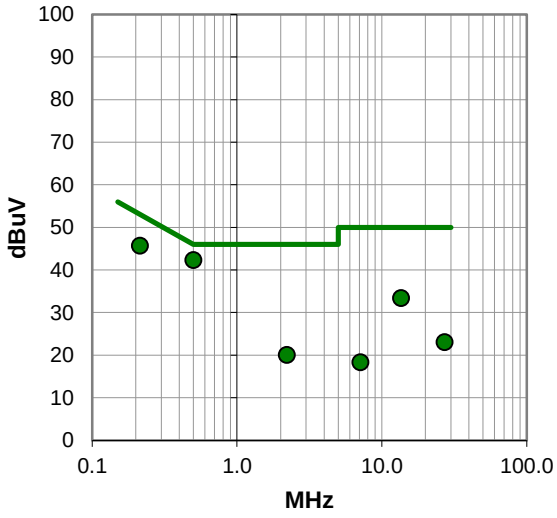
DEVIATIONS FROM TEST STANDARD

None

Quasi Peak Data - vs - Quasi Peak Limit



Average Data - vs - Average Limit



POWERLINE CONDUCTED EMISSIONS

WTD.2017.11.22.1

RESULTS - Run #13

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.499	23.2	20.4	43.6	56.0	-12.4
0.214	28.2	20.6	48.8	63.0	-14.2
13.570	17.3	21.6	38.9	60.0	-21.1
7.142	11.4	20.9	32.3	60.0	-27.7
27.128	4.3	23.6	27.9	60.0	-32.1
2.214	2.4	20.5	22.9	56.0	-33.1

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.499	21.9	20.4	42.3	46.0	-3.7
0.214	25.1	20.6	45.7	53.0	-7.3
13.570	11.8	21.6	33.4	50.0	-16.6
2.214	-0.5	20.5	20.0	46.0	-26.0
27.128	-0.6	23.6	23.0	50.0	-27.0
7.142	-2.6	20.9	18.3	50.0	-31.7

CONCLUSION

Pass

Tested By

FIELD STRENGTH OF FUNDAMENTAL

PSA-ESCI 2017.12.19

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

Transmitting RFID 13.56 MHz

POWER SETTINGS INVESTIGATED

110VAC/60Hz

CONFIGURATIONS INVESTIGATED

CSYS0026 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	490 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
Cable	ESM Cable Corp.	Antenna Loop Cable	MNE	16-Feb-2018	12 mo
Antenna - Loop	ETS Lindgren	6502	AOB	16-May-2017	24 mo
Analyzer - Spectrum Analyzer	Agilent	E4443A	AAS	27-Feb-2018	12 mo

MEASUREMENT BANDWIDTHS

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01 - 0.15	1.0	0.2	0.2
0.15 - 30.0	10.0	9.0	9.0
30.0 - 1000	100.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

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.

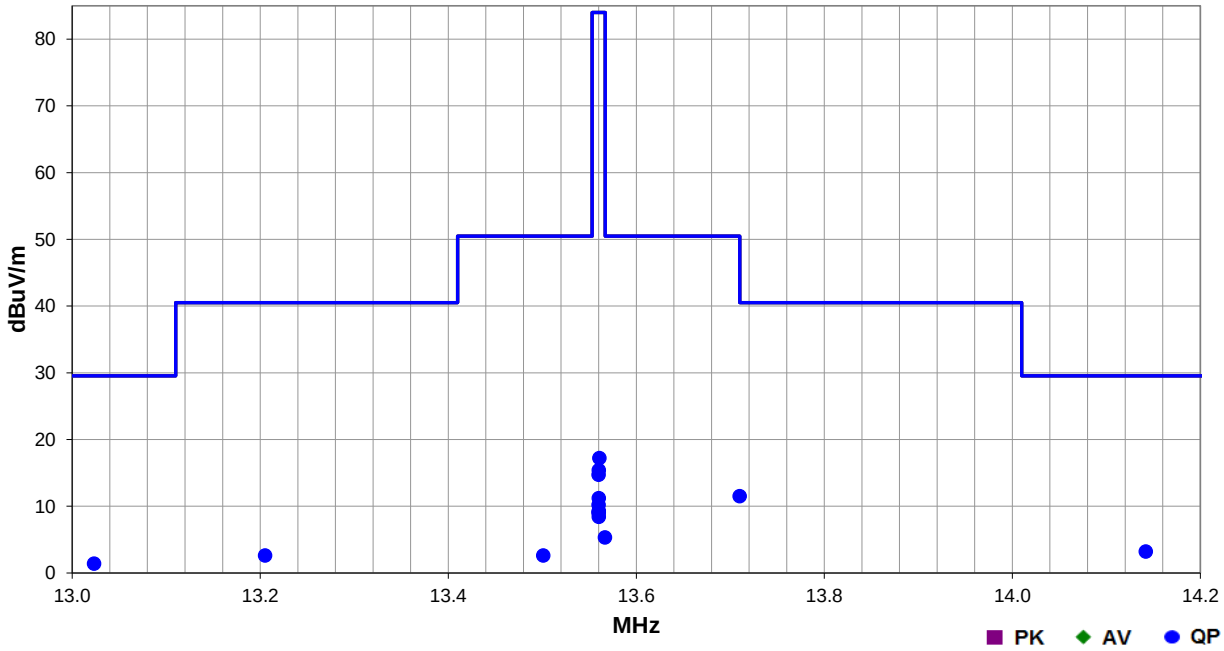
FIELD STRENGTH OF FUNDAMENTAL

EmiR5 2018.02.06 PSA-ESCI 2017.12.19

Work Order:	CSYS0026	**Date:**	26-Mar-2018		
Project:	None	**Temperature:**	22.7 °C		
Job Site:	MN04	**Humidity:**	19.9% RH		
Serial Number:	220692	**Barometric Pres.:**	1023 mbar	**Tested by:**	Dustin Sparks
EUT:	Exchangeable OAD				
Configuration:	1				
Customer:	Cardiovascular Systems, Inc.				
Attendees:	Michael Welsch, Brian Schmaltz				
EUT Power:	110VAC/60Hz				
Operating Mode:	Transmitting RFID, 13.56 MHz modulated				
Deviations:	None				
Comments:	None				

Test Specifications	**Test Method**
FCC 15.225:2018	ANSI C63.10:2013

Run #	0	**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
14.142	11.5	10.8	1.0	245.0	10.0	0.0	Perp to GND	QP	-19.1	3.2	29.5	-26.3	EUT vertical
13.023	9.7	10.8	1.0	187.0	10.0	0.0	Perp to GND	QP	-19.1	1.4	29.5	-28.1	EUT vertical
13.205	10.9	10.8	1.0	85.0	10.0	0.0	Perp to GND	QP	-19.1	2.6	40.5	-37.9	EUT vertical
13.710	19.8	10.8	1.0	320.0	10.0	0.0	Perp to GND	QP	-19.1	11.5	50.5	-39.0	EUT vertical
13.501	10.9	10.8	1.0	279.0	10.0	0.0	Perp to GND	QP	-19.1	2.6	50.5	-47.9	EUT vertical
13.561	25.5	10.8	1.0	280.0	10.0	0.0	Perp to GND	QP	-19.1	17.2	84.0	-66.8	EUT vertical
13.560	23.7	10.8	1.0	233.0	10.0	0.0	Perp to GND	QP	-19.1	15.4	84.0	-68.6	EUT on side
13.560	23.0	10.8	1.0	105.0	10.0	0.0	Perp to GND	QP	-19.1	14.7	84.0	-69.3	EUT horizontal
13.560	19.5	10.8	1.0	215.0	10.0	0.0	Par to GND	QP	-19.1	11.2	84.0	-72.8	EUT vertical
13.560	18.5	10.8	1.0	110.0	10.0	0.0	Par to EUT	QP	-19.1	10.2	84.0	-73.8	EUT vertical
13.560	17.6	10.8	1.0	31.0	10.0	0.0	Par to EUT	QP	-19.1	9.3	84.0	-74.7	EUT horizontal
13.560	17.4	10.8	1.0	66.0	10.0	0.0	Par to GND	QP	-19.1	9.1	84.0	-74.9	EUT horizontal
13.560	17.3	10.8	1.0	77.0	10.0	0.0	Par to EUT	QP	-19.1	9.0	84.0	-75.0	EUT on side
13.560	16.7	10.8	1.0	211.0	10.0	0.0	Par to GND	QP	-19.1	8.4	84.0	-75.6	EUT on side
13.567	13.6	10.8	1.0	219.0	10.0	0.0	Perp to GND	QP	-19.1	5.3	84.0	-78.7	EUT vertical

FIELD STRENGTH OF SPURIOUS EMISSIONS LESS THAN 30 MHZ

PSA-ESCI 2017.12.19

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

Transmitting RFID, 13.56 MHz modulated

POWER SETTINGS INVESTIGATED

110VAC/60Hz

CONFIGURATIONS INVESTIGATED

CSYS0026 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	490 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
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFG	19-Jun-2017	12 mo
Cable	ESM Cable Corp.	Antenna Loop Cable	MNE	16-Feb-2018	12 mo
Antenna - Loop	ETS Lindgren	6502	AOB	16-May-2017	24 mo

MEASUREMENT BANDWIDTHS

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01 - 0.15	1.0	0.2	0.2
0.15 - 30.0	10.0	9.0	9.0
30.0 - 1000	100.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

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.

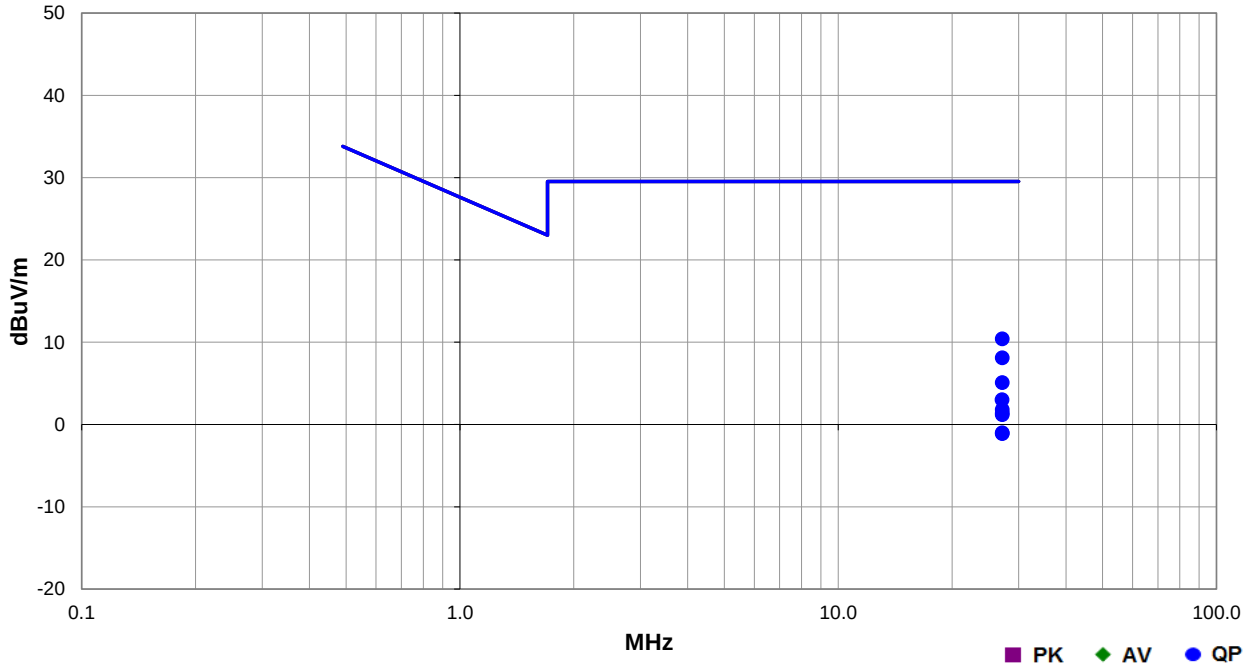
FIELD STRENGTH OF SPURIOUS EMISSIONS LESS THAN 30 MHZ

EmiR5 2018.02.06 PSA-ESCI 2017.12.19

Work Order:	CSYS0026	**Date:**	26-Mar-2018		
Project:	None	**Temperature:**	22.1 °C		
Job Site:	MN04	**Humidity:**	23.6% RH		
Serial Number:	220692	**Barometric Pres.:**	1019 mbar	**Tested by:**	Dustin Sparks
EUT:	Exchangeable OAD				
Configuration:	1				
Customer:	Cardiovascular Systems, Inc.				
Attendees:	Michael Welsch				
EUT Power:	110VAC/60Hz				
Operating Mode:	Transmitting RFID, 13.56 MHz modulated				
Deviations:	None				
Comments:	None				

Test Specifications	**Test Method**
FCC 15.225:2018	ANSI C63.10:2013

Run #	23	**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
27.136	20.2	9.3	1.0	283.0	10.0	0.0	Par to GND	QP	-19.1	10.4	29.5	-19.1	EUT vertical
27.140	17.9	9.3	1.0	0.0	10.0	0.0	Par to EUT	QP	-19.1	8.1	29.5	-21.4	EUT vertical
27.135	14.9	9.3	1.0	319.0	10.0	0.0	Par to GND	QP	-19.1	5.1	29.5	-24.4	EUT horizontal
27.121	12.8	9.3	1.0	341.0	10.0	0.0	Par to GND	QP	-19.1	3.0	29.5	-26.5	EUT on side
27.141	11.6	9.3	1.0	265.0	10.0	0.0	Perp to GND	QP	-19.1	1.8	29.5	-27.7	EUT vertical
27.132	11.2	9.3	1.0	360.0	10.0	0.0	Par to EUT	QP	-19.1	1.4	29.5	-28.1	EUT horizontal
27.125	11.0	9.3	1.0	37.0	10.0	0.0	Par to EUT	QP	-19.1	1.2	29.5	-28.3	EUT on side
27.126	8.8	9.3	1.0	348.0	10.0	0.0	Perp to GND	QP	-19.1	-1.0	29.5	-30.5	EUT on side
27.135	8.7	9.3	1.0	353.0	10.0	0.0	Perp to GND	QP	-19.1	-1.1	29.5	-30.6	EUT horizontal

FIELD STRENGTH OF SPURIOUS EMISSIONS GREATER THAN 30 MHZ

PSA-ESCI 2017.12.19

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

Transmitting RFID, 13.56 MHz modulated

POWER SETTINGS INVESTIGATED

110VAC/60Hz

CONFIGURATIONS INVESTIGATED

CSYS0026 - 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
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AVO	9-Nov-2017	12 mo
Cable	ESM Cable Corp.	Bilog Cables	MNH	9-Nov-2017	12 mo
Antenna - Biconilog	Teseq	CBL 6141B	AYD	25-Jan-2018	24 mo
Analyzer - Spectrum Analyzer	Keysight	N9010A (EXA)	AFQ	19-Dec-2017	12 mo

MEASUREMENT BANDWIDTHS

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01 - 0.15	1.0	0.2	0.2
0.15 - 30.0	10.0	9.0	9.0
30.0 - 1000	100.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

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.

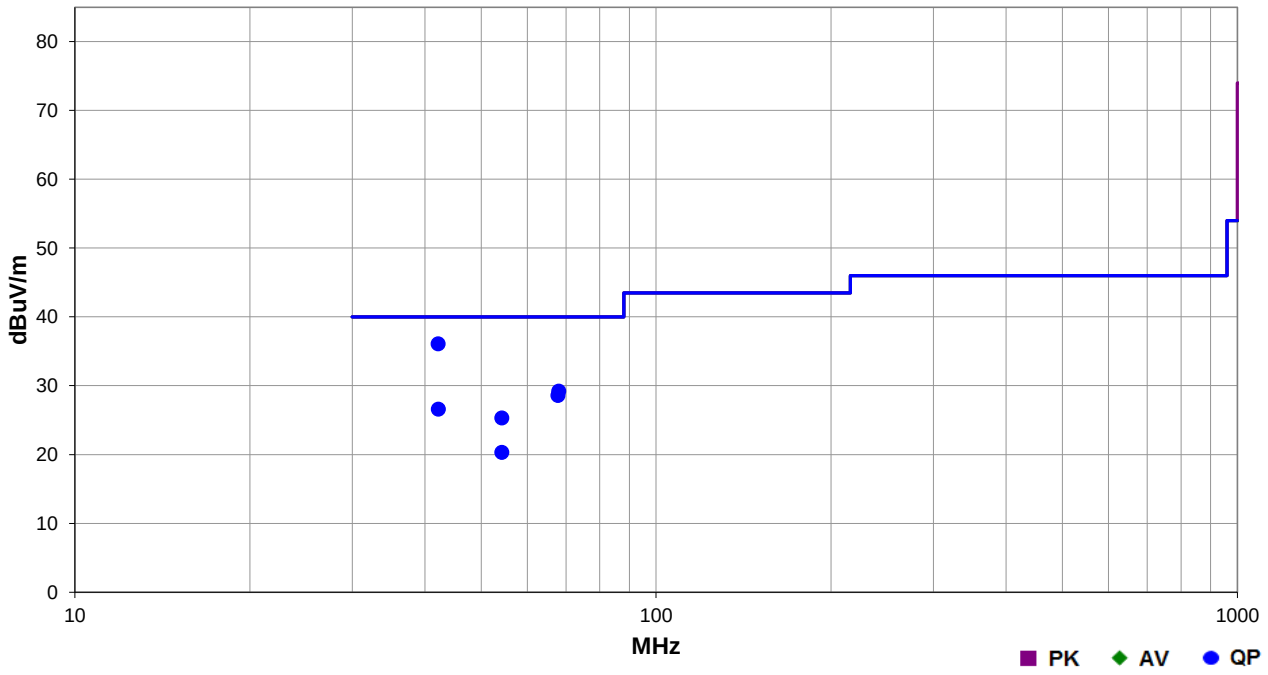
FIELD STRENGTH OF SPURIOUS EMISSIONS GREATER THAN 30 MHZ

EmiR5 2018.02.06 PSA-ESCI 2017.12.19

Work Order:	CSYS0026	**Date:**	27-Mar-2018		
Project:	None	**Temperature:**	22.5 °C		
Job Site:	MN05	**Humidity:**	24.3% RH		
Serial Number:	220692	**Barometric Pres.:**	1021 mbar	**Tested by:**	Dustin Sparks
EUT:	Exchangeable OAD				
Configuration:	1				
Customer:	Cardiovascular Systems, Inc.				
Attendees:	Michael Welsch				
EUT Power:	110VAC/60Hz				
Operating Mode:	Transmitting RFID, 13.56 MHz modulated				
Deviations:	None				
Comments:	None				

Test Specifications	**Test Method**
FCC 15.225:2018	ANSI C63.10:2013

Run #	2	**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
42.157	36.4	-0.3	1.0	37.1	3.0	0.0	Vert	QP	0.0	36.1	40.0	-3.9	EUT vertical
67.998	38.5	-9.3	4.0	200.0	3.0	0.0	Horz	QP	0.0	29.2	40.0	-10.8	EUT vertical
67.748	37.9	-9.3	1.9	65.1	3.0	0.0	Vert	QP	0.0	28.6	40.0	-11.4	EUT vertical
42.188	26.9	-0.3	1.0	25.0	3.0	0.0	Horz	QP	0.0	26.6	40.0	-13.4	EUT vertical
54.253	30.8	-5.5	1.0	129.0	3.0	0.0	Vert	QP	0.0	25.3	40.0	-14.7	EUT vertical
54.248	25.8	-5.5	3.5	32.0	3.0	0.0	Horz	QP	0.0	20.3	40.0	-19.7	EUT vertical

FREQUENCY STABILITY

XMit 2017.12.13

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
Meter - Multimeter	Fluke	117	MLS	23-Jan-17	23-Jan-20
Chamber - Temperature/Humidity	Cincinnati Sub Zero (CSZ)	ZPH-32-3.5-SCT/AC	TBF	NCR	NCR
Thermometer	Omega Engineering, Inc.	HH311	DUB	10-Nov-17	10-Nov-20
Probe - Near Field Set	ETS Lindgren	7405	IPO	NCR	NCR
Cable	ESM Cable Corp.	TTBJ141 KMKM-72	MNU	15-Mar-18	15-Mar-19
Analyzer - Spectrum Analyzer	Agilent	E4440A	AFD	2-Aug-17	2-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:

ppm = (Measured Frequency / Measured Nominal Frequency - 1) * 1,000,000

FREQUENCY STABILITY

TbtTx 2017.12.14 XMit 2017.12.13

EUT:	**Exchangeable OAD**			**Work Order:**	**CSYS0026**
Serial Number:	**220692**			**Date:**	**29-Mar-18**
Customer:	**Cardiovascular Systems, Inc.**			**Temperature:**	**22.5 °C**
Attendees:	**Michael Welsch**			**Humidity:**	**21.3% RH**
Project:	**None**			**Barometric Pres.:**	**1023 mbar**
Tested by:	**Dustin Sparks**	**Power:**	**110VAC/60Hz**	**Job Site:**	**MN08**

TEST SPECIFICATIONS	**Test Method**
FCC 15.225:2018	ANSI C63.10:2013

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

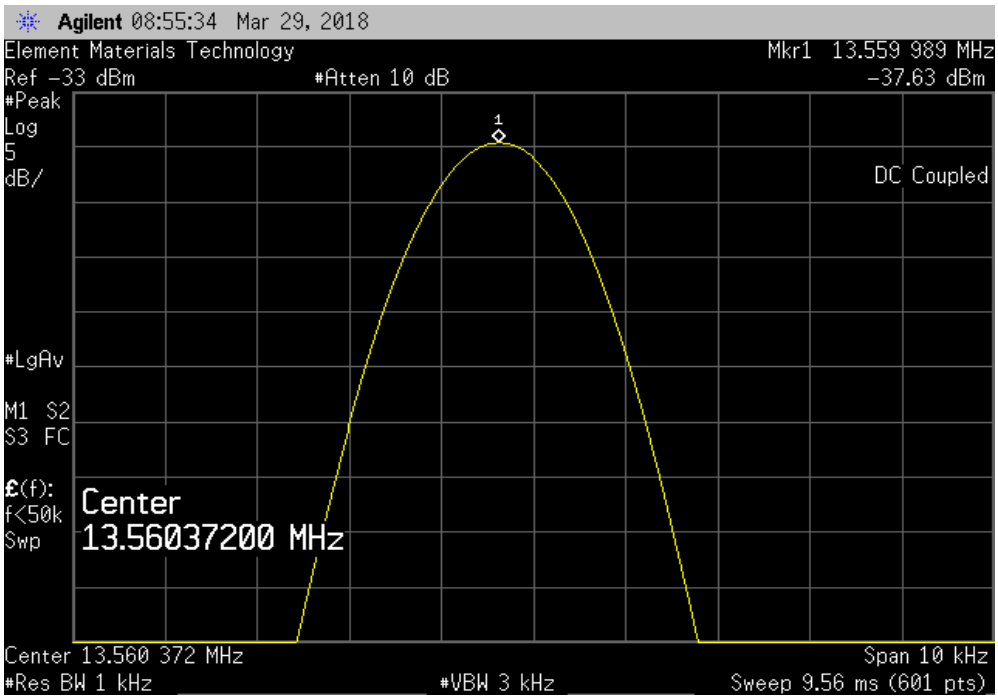
Configuration #	**1**	*Signature* Dustin Sparks

	Measured Value (MHz)	**Assigned Value (MHz)**	**Error (ppm)**	**Limit (ppm)**	**Results**
13.56 MHz RFID					
Temperature: +50°	13.559989	13.56	0.8	100	Pass
Temperature: +40°	13.559989	13.56	0.8	100	Pass
Temperature: +30°	13.560005	13.56	0.4	100	Pass
Temperature: +20°	13.560037	13.56	2.7	100	Pass
Temperature: +20°, Voltage: 85%	13.560039	13.56	2.9	100	Pass
Temperature: +20°, Voltage: 115%	13.560056	13.56	4.1	100	Pass
Temperature: +10°	13.560072	13.56	5.3	100	Pass
Temperature: 0°	13.560122	13.56	9	100	Pass
Temperature: -10°	13.560153	13.56	11.3	100	Pass
Temperature: -20°	13.560139	13.56	10.3	100	Pass

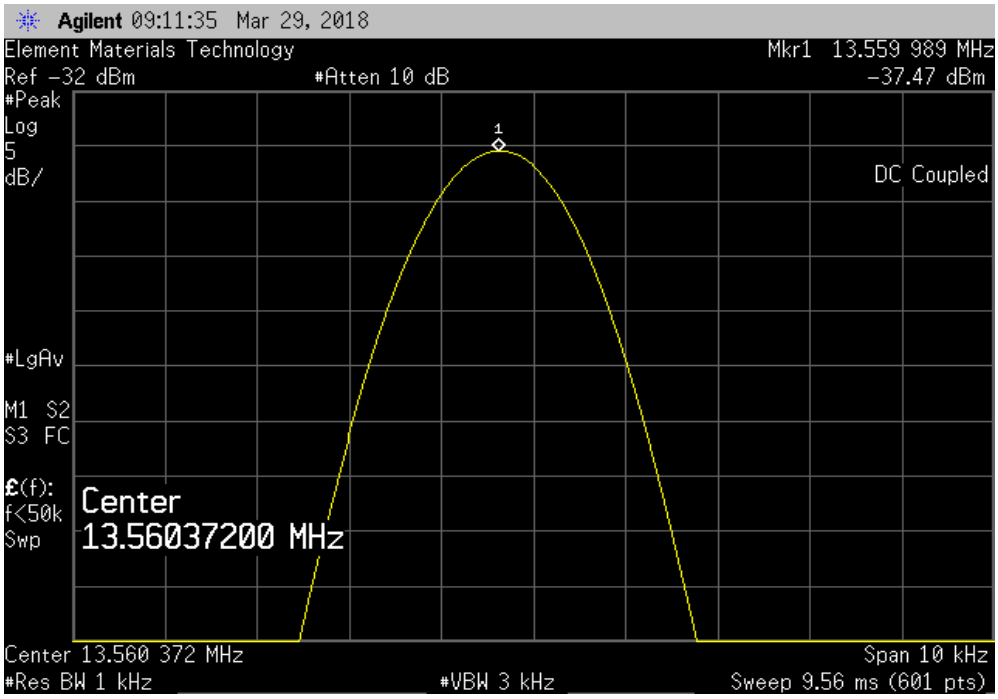
FREQUENCY STABILITY

TbtTx 2017.12.14 XMit 2017.12.13

13.56 MHz RFID, Temperature: +50°						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Results
		13.559989	13.56	0.8	100	Pass



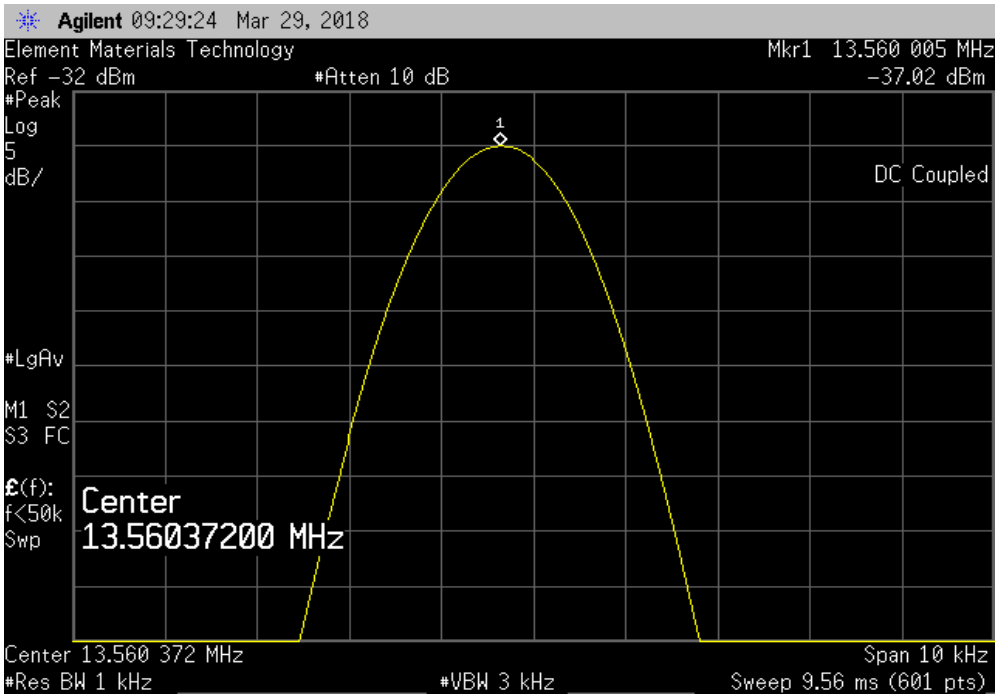
13.56 MHz RFID, Temperature: +40°						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Results
		13.559989	13.56	0.8	100	Pass



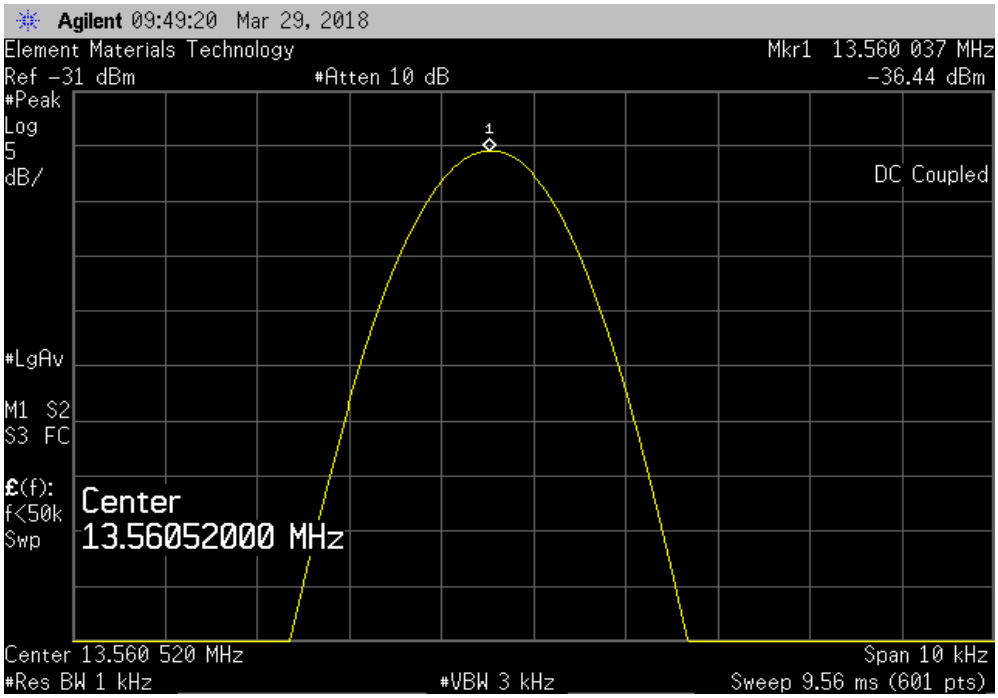
FREQUENCY STABILITY

TbtTx 2017.12.14 XMit 2017.12.13

13.56 MHz RFID, Temperature: +30°						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Results
		13.560005	13.56	0.4	100	Pass



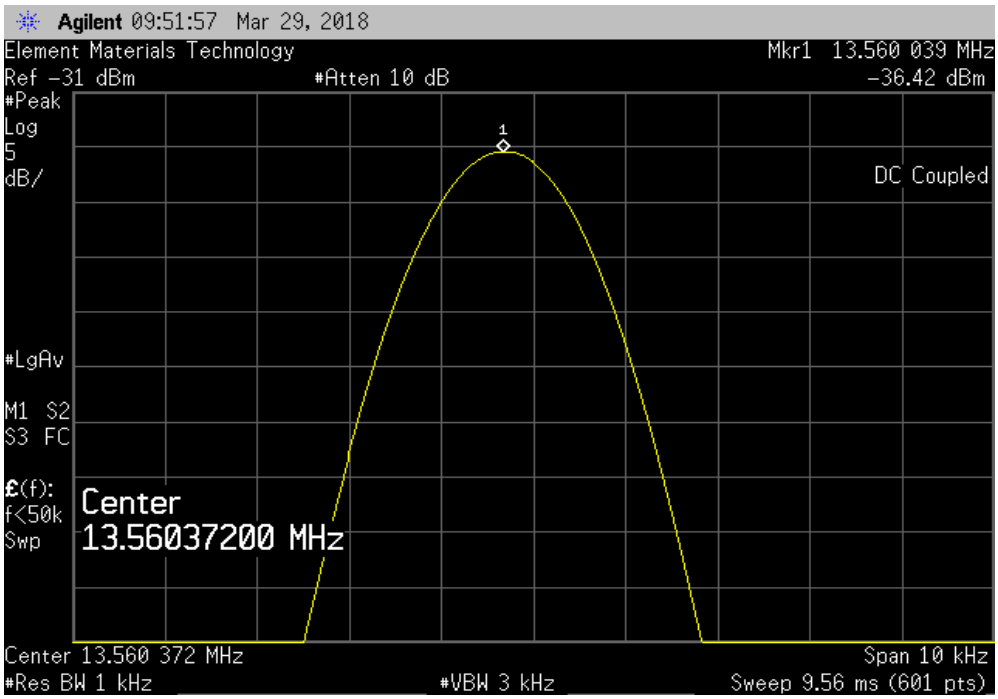
13.56 MHz RFID, Temperature: +20°						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Results
		13.560037	13.56	2.7	100	Pass



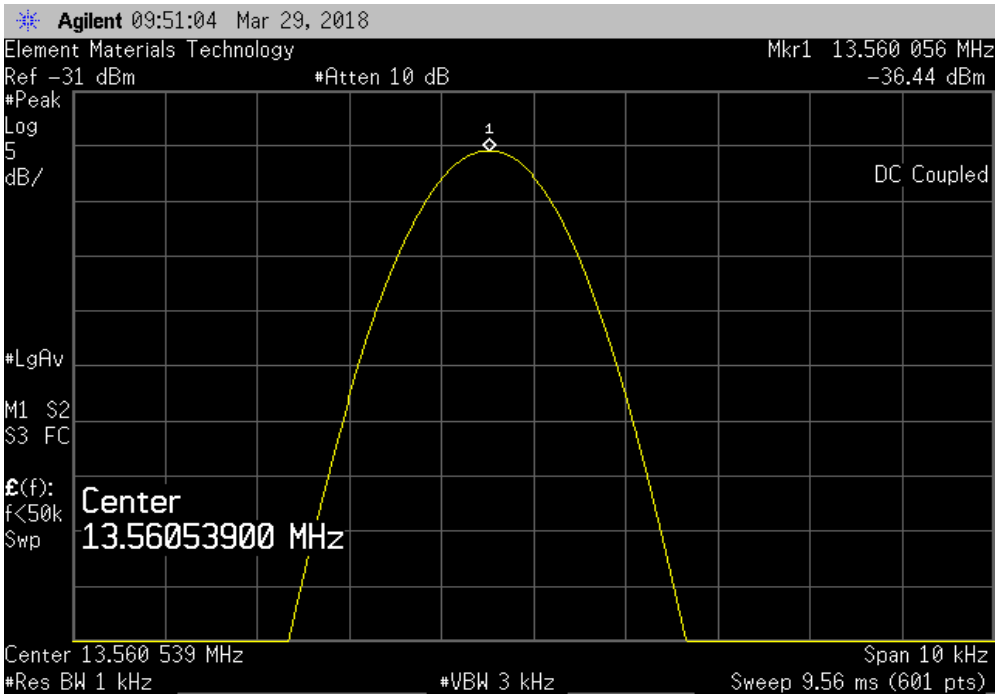
FREQUENCY STABILITY

TbtTx 2017.12.14 XMit 2017.12.13

13.56 MHz RFID, Temperature: +20°, Voltage: 85%						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Results
		13.560039	13.56	2.9	100	Pass



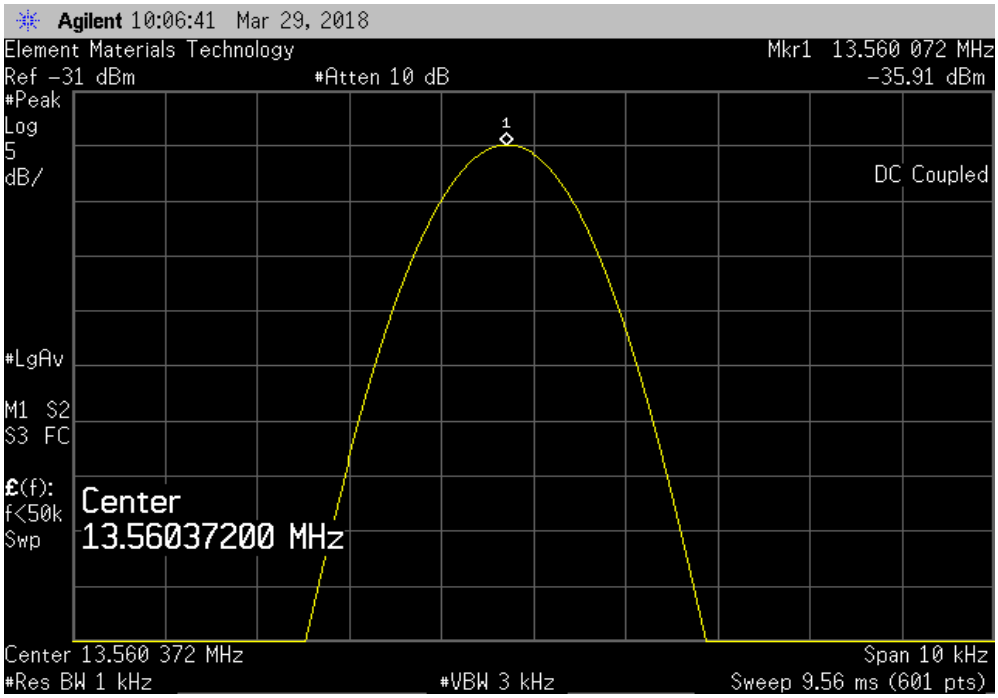
13.56 MHz RFID, Temperature: +20°, Voltage: 115%						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Results
		13.560056	13.56	4.1	100	Pass



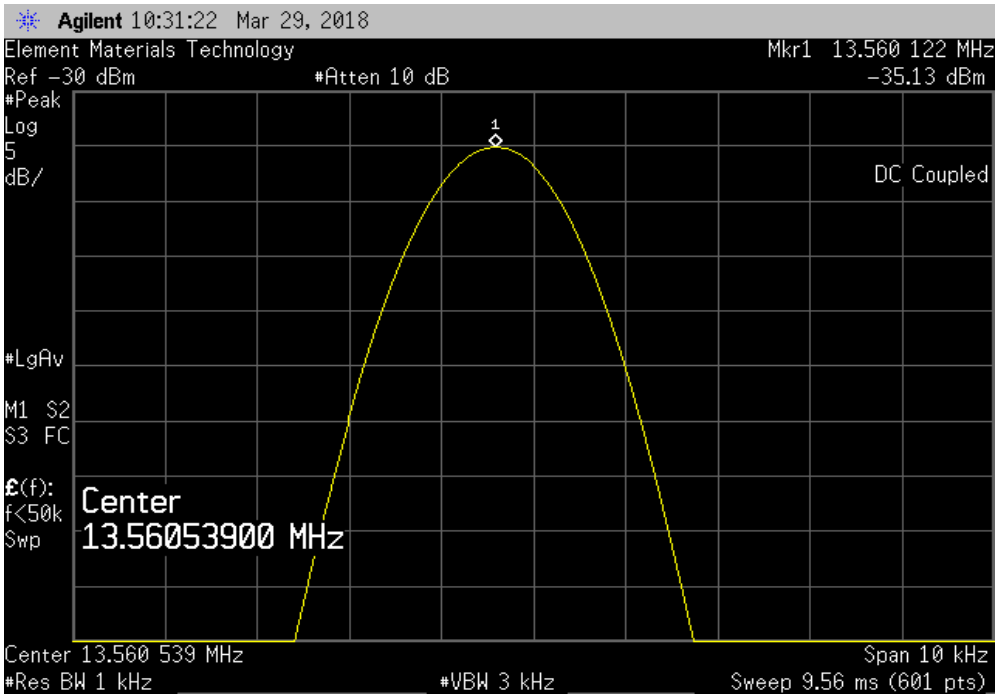
FREQUENCY STABILITY

TbtTx 2017.12.14 XMit 2017.12.13

13.56 MHz RFID, Temperature: +10°						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Results
		13.560072	13.56	5.3	100	Pass



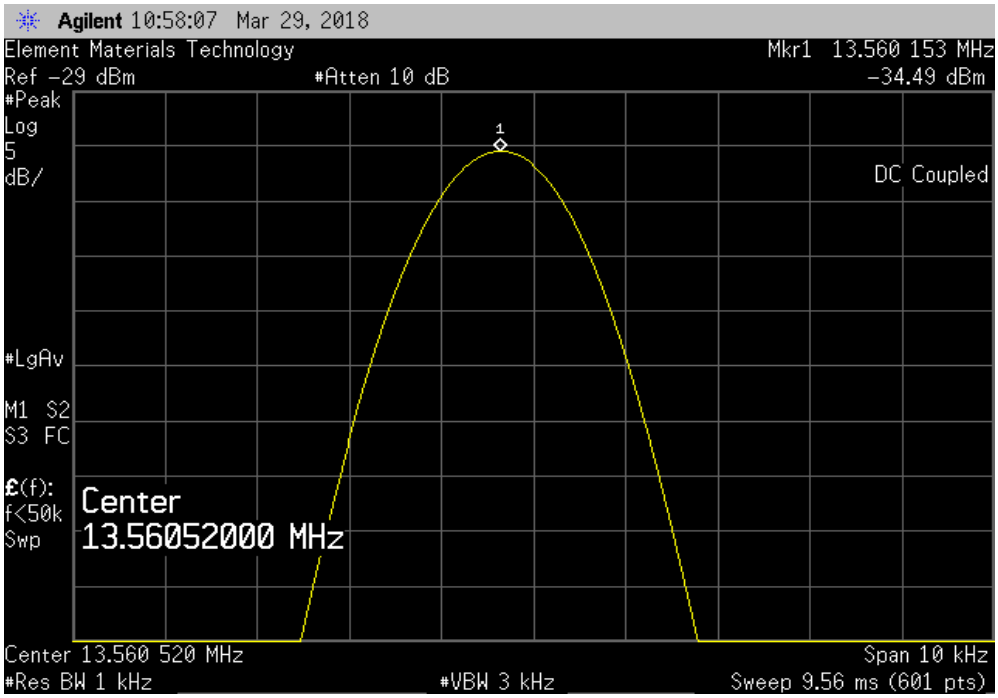
13.56 MHz RFID, Temperature: 0°						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Results
		13.560122	13.56	9	100	Pass



FREQUENCY STABILITY

TbtTx 2017.12.14 XMit 2017.12.13

13.56 MHz RFID, Temperature: -10°						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Results
		13.560153	13.56	11.3	100	Pass



13.56 MHz RFID, Temperature: -20°						
		Measured Value (MHz)	Assigned Value (MHz)	Error (ppm)	Limit (ppm)	Results
		13.560139	13.56	10.3	100	Pass