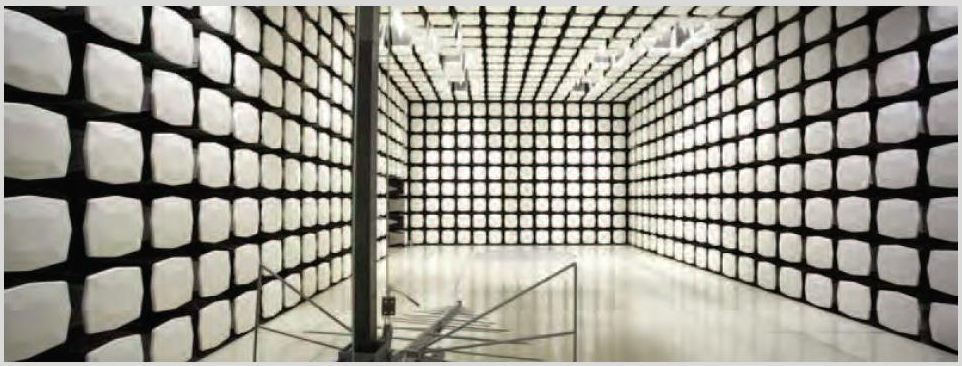
CINCH Systems

RF-Water-433-CLR

FCC 15.231:2020

Low Power Radio

Report: CINC0052.12, Issue Date: July 6, 2020



NVLAP LAB CODE: 200881-0

CERTIFICATE OF TEST

Last Date of Test: June 1, 2020
CINCH Systems
EUT: RF-Water-433-CLR

Radio Equipment Testing

Standards

Specification	Method
FCC 15.231:2020	ANSI C63.10:2013

Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions (Transmitter)	No	N/A	Not required for a battery powered EUT.
6.5, 6.6	Field Strength of Fundamental	Yes	Pass	
6.5, 6.6	Spurious Radiated Emissions	Yes	Pass	
6.9.2	Occupied Bandwidth	Yes	Pass	
7.5	Duty Cycle	Yes	N/A	

Deviations From Test Standards

None

Approved By:

Eric Brandon, Department 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. As indicated in the Statement of Work sent with the quotation, Element's standard process is to always use the latest published version of the test methods even when earlier versions are cited in the test specification. Issuance of a purchase order was de facto acceptance of this approach. Otherwise, the client would have advised Element in writing of the specific version of the test methods they wanted applied to the subject testing.

REVISION HISTORY

Revision Number	Description	Date (yyyy-mm-dd)	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) and as a CAB for the acceptance of test data.

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

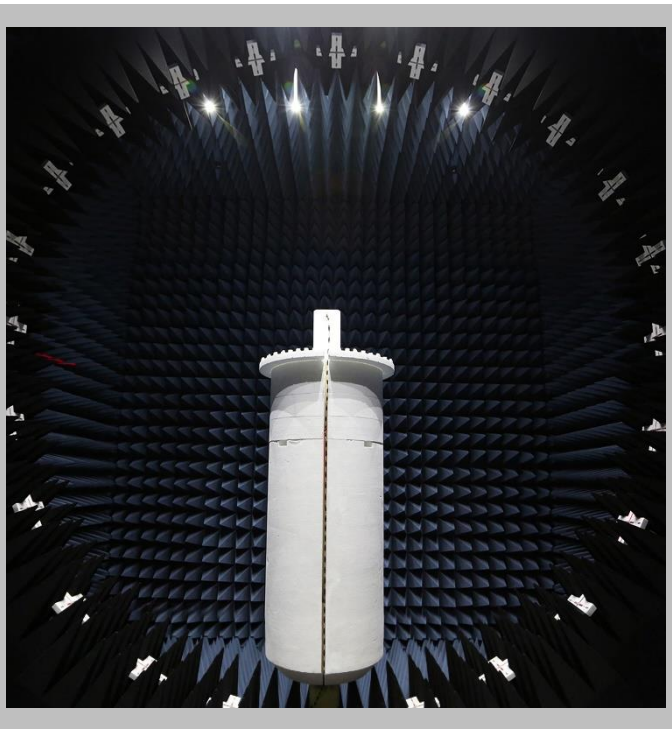
MIC – Recognized by MIC as a CAB for the acceptance of test data.

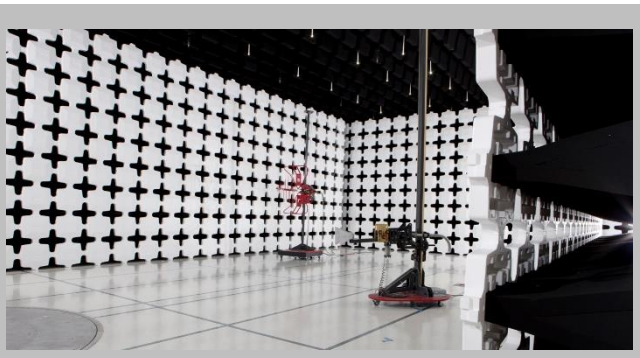
SCOPE

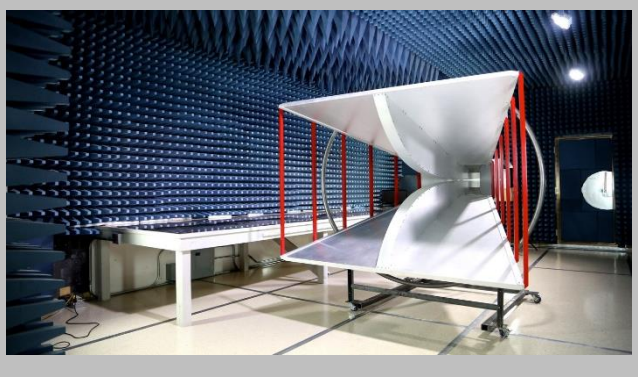
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

FACILITIES

California	Minnesota	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 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: 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	2834D-1	2834G-1	2834F-1
BSMI				
SL2-IN-E-1154R	SL2-IN-E-1152R	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI				
A-0029	A-0109	A-0108	A-0201	A-0110
Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA				
US0158	US0175	US0017	US0191	US0157







MEASUREMENT UNCERTAINTY

element
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.

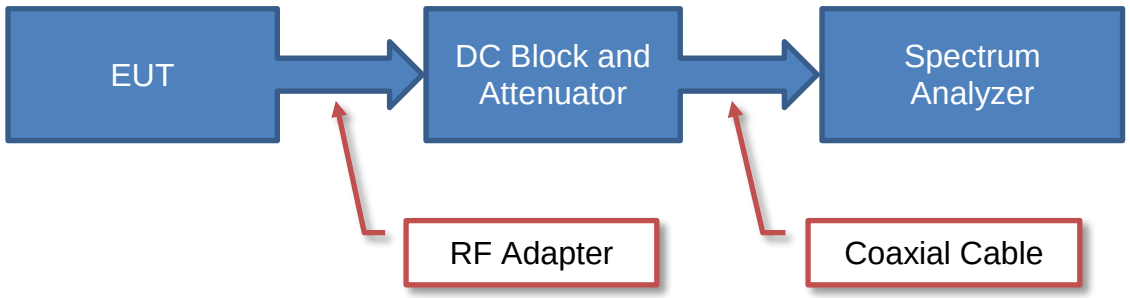
A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable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

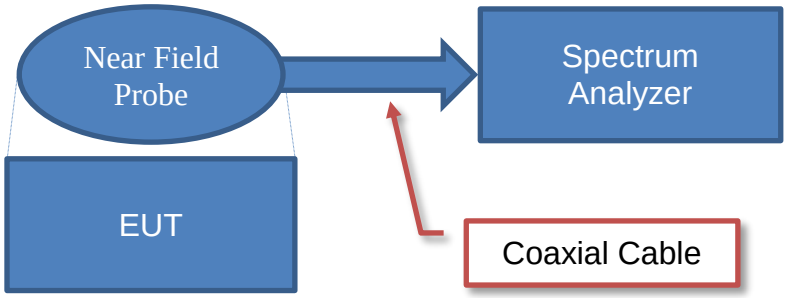
Test	+ MU	- MU
Frequency Accuracy	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	1.2 dB	-1.2 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.2 dB	-5.2 dB
AC Powerline Conducted Emissions (dB)	2.6 dB	-2.6 dB

Test Setup Block Diagrams

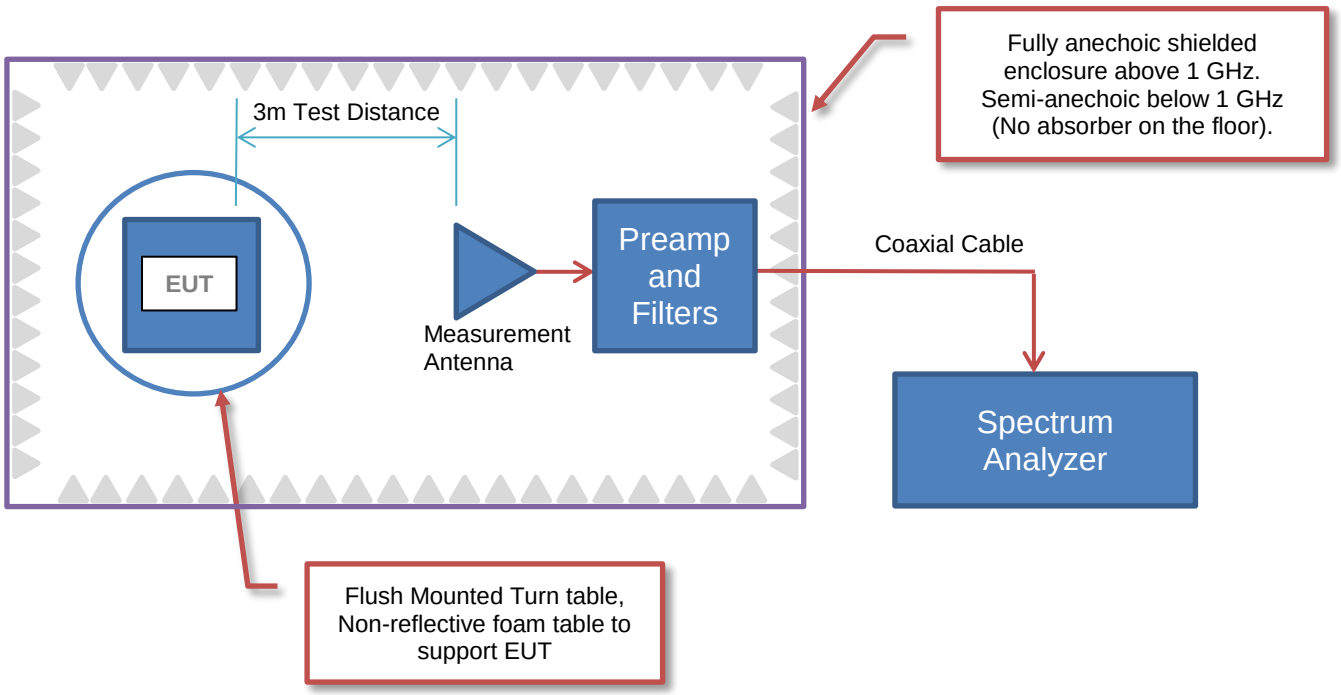
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions



PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	CINCH Systems
Address:	Suite 300 12075 43rd Street NE
City, State, Zip:	St. Michael, MN 55376
Test Requested By:	Jibril Aga
EUT:	RF-Water-433-CLR
First Date of Test:	April 13, 2020
Last Date of Test:	June 1, 2020
Receipt Date of Samples:	April 13, 2020
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
Sensors containing periodic radio.

Testing Objective:
To demonstrate compliance to FCC 15.231 specifications.

CONFIGURATIONS

Configuration CINC0052- 11

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Water Sensor (Transmitter)	CINCH Systems	RF-Water-433-CLR	2090414

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Water Sensor	CINCH Systems	N/A	N/A

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
Water Sensor Cable	No	2.2m	No	Water Sensor	Water Sensor (Transmitter)

Configuration CINC0052- 12

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Water Sensor (Transmitter)	CINCH Systems	RF-Water-433-CLR	741138

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Water Sensor	CINCH Systems	N/A	N/A

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
Water Sensor Cable	No	2.2m	No	Water Sensor	Water Sensor (Transmitter)

Configuration CINC0052- 13

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Water Sensor (Transmitter)	CINCH Systems	RF-Water-433-CLR	438673

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Water Sensor	CINCH Systems	N/A	N/A

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
Water Sensor Cable	No	2.2m	No	Water Sensor	Water Sensor (Transmitter)

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2020-06-01	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	2020-06-01	Spurious Radiated 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.
3	2020-06-01	Occupied Bandwidth	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	2020-06-01	Duty Cycle	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

FIELD STRENGTH OF FUNDAMENTAL

PSA-ESCI 2020.04.03.0

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 433.95 MHz CW

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

CINC0052 - 11

FREQUENCY RANGE INVESTIGATED

Start Frequency	433 MHz	Stop Frequency	435 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.	Bilog Cables	MNH	2019-10-18	12 mo
Antenna - Biconilog	ETS Lindgren	3142D	AXO	2019-09-03	24 mo
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	2020-04-14	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 configured for continuous un-modulated CW operation at its single transmit frequency. The field strength of the transmit frequency was maximized by rotating the EUT, adjusting the measurement antenna height and polarization, and manipulating the EUT in 3 orthogonal planes (per ANSI C63.10:2013).

To derive average emission measurements, a duty cycle correction factor was utilized:

Duty Cycle = On time/100 milliseconds (or the period, whichever is less)

Where “On time” = N1L1 +N2L2 +….

Where N1 is the number of type 1 pulses, L1 is length of type 1 pulses, N2 is the number of type 2 pulses, L2 is the length of type 2 pulses, etc.

Therefore, Duty Cycle = (N1L1 +N2L2 +…)/100mS or T, whichever is less. (Where T is the period of the pulse train.)

The measured values for the EUT’s pulse train are as follows:

Period = 100 mSec
Pulsewidth of Type 1 Pulse = 0.0947 mSec
Pulsewidth of Type 2 Pulse = 0.208 mSec
Number of Type 1 Pulses = 46
Number of Type 2 Pulses = 23

Duty Cycle Correction Factor = 20 log [((0.0947)(46) + (0.208)(23))/100] = -20.8 dB

The duty cycle correction factor of -20.8 dB was added to the peak readings to mathematically derive the average levels.

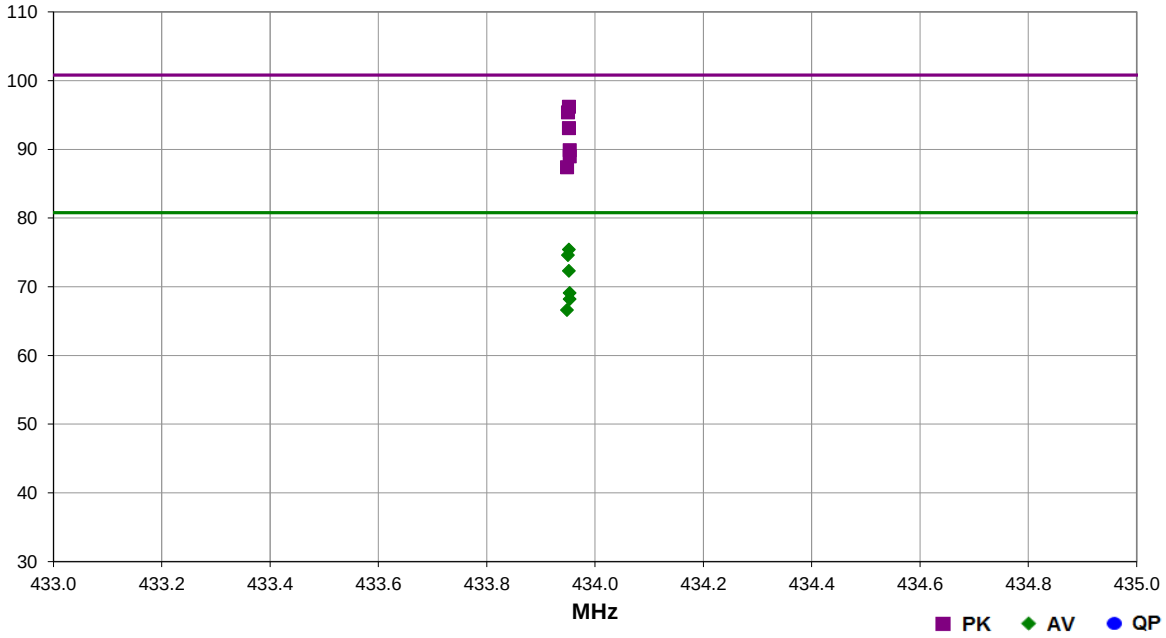
FIELD STRENGTH OF FUNDAMENTAL

EmiR5 2020.04.20.0 PSA-ESCI 2020.04.03.0

Work Order:	CINC0052	**Date:**	2020-06-01		
Project:	None	**Temperature:**	23.1 °C		
Job Site:	MN05	**Humidity:**	45.2% RH		
Serial Number:	2090414	**Barometric Pres.:**	1015 mbar	**Tested by:**	Dustin Sparks
EUT:	RF-Water-433-CLR				
Configuration:	11				
Customer:	CINCH Systems				
Attendees:	Jibril Aga				
EUT Power:	Battery				
Operating Mode:	Transmitting 433.95 MHz CW				
Deviations:	None				
Comments:	None				

Test Specifications	**Test Method**
FCC 15.231:2020	ANSI C63.10:2013

Run #	19	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
433.952	72.4	23.8	1.0	153.9		0.0	Horz	PK	0.0	96.2	100.8	-4.6	EUT horizontal
433.952	72.4	23.8	1.0	153.9	-20.8	0.0	Horz	AV	0.0	75.4	80.8	-5.4	EUT horizontal
433.950	71.6	23.8	1.0	173.0		0.0	Horz	PK	0.0	95.4	100.8	-5.4	EUT vertical
433.950	71.6	23.8	1.0	173.0	-20.8	0.0	Horz	AV	0.0	74.6	80.8	-6.2	EUT vertical
433.952	69.3	23.8	1.0	170.0		0.0	Horz	PK	0.0	93.1	100.8	-7.7	EUT on side
433.952	69.3	23.8	1.0	170.0	-20.8	0.0	Horz	AV	0.0	72.3	80.8	-8.5	EUT on side
433.953	66.1	23.8	2.4	113.0		0.0	Vert	PK	0.0	89.9	100.8	-10.9	EUT vertical
433.953	66.1	23.8	2.4	113.0	-20.8	0.0	Vert	AV	0.0	69.1	80.8	-11.7	EUT vertical
433.953	65.2	23.8	2.5	106.9		0.0	Vert	PK	0.0	89.0	100.8	-11.8	EUT horizontal
433.953	65.2	23.8	2.5	106.9	-20.8	0.0	Vert	AV	0.0	68.2	80.8	-12.6	EUT horizontal
433.948	63.6	23.8	1.5	249.0		0.0	Vert	PK	0.0	87.4	100.8	-13.4	EUT on side
433.948	63.6	23.8	1.5	249.0	-20.8	0.0	Vert	AV	0.0	66.6	80.8	-14.2	EUT on side

SPURIOUS RADIATED EMISSIONS

PSA-ESCI 2020.04.03.0

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 433.95 MHz CW

POWER SETTINGS INVESTIGATED

Battery

CONFIGURATIONS INVESTIGATED

CINC0052 - 11

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	6000 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
Filter - Low Pass	Micro-Tronics	LPM50003	LFJ	2019-09-17	12 mo
Filter - High Pass	Micro-Tronics	HPM50108	LFM	2019-09-12	12 mo
Attenuator	Fairview Microwave	SA18E-10	TYA	2019-09-17	12 mo
Attenuator	Fairview Microwave	SA18E-20	TWZ	2019-09-17	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVT	2020-01-17	12 mo
Cable	ESM Cable Corp.	Double Ridge Guide Horn Cables	MNI	2019-09-17	12 mo
Antenna - Double Ridge	ETS-Lindgren	3115	AJQ	2019-01-16	24 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AVO	2019-10-18	12 mo
Cable	ESM Cable Corp.	Bilog Cables	MNH	2019-10-18	12 mo
Antenna - Biconilog	ETS Lindgren	3142D	AXO	2019-09-03	24 mo
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	2020-04-14	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 highest gain antenna of each type to be used with the EUT was tested. The EUT was configured for the required transmit frequency in each operational band and the modes as showed in the data sheets.

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

To derive average emission measurements, a duty cycle correction factor was utilized:

Duty Cycle = On time/100 milliseconds (or the period, whichever is less)

Where “On time” = N1L1 +N2L2 +….

Where N1 is the number of type 1 pulses, L1 is length of type 1 pulses, N2 is the number of type 2 pulses, L2 is the length of type 2 pulses, etc.

Therefore, Duty Cycle = (N1L1 +N2L2 +…)/100mS or T, whichever is less. (Where T is the period of the pulse train.)

The measured values for the EUT’s pulse train are as follows:

Period = 100 mSec
Pulsewidth of Type 1 Pulse = 0.0947 mSec
Pulsewidth of Type 2 Pulse = 0.208 mSec
Number of Type 1 Pulses = 46
Number of Type 2 Pulses = 23

Duty Cycle Correction Factor = 20 log [((0.0947)(46) + (0.208)(23))/100] = -20.8 dB

The duty cycle correction factor of -20.8 dB was added to the peak readings to mathematically derive the average levels.

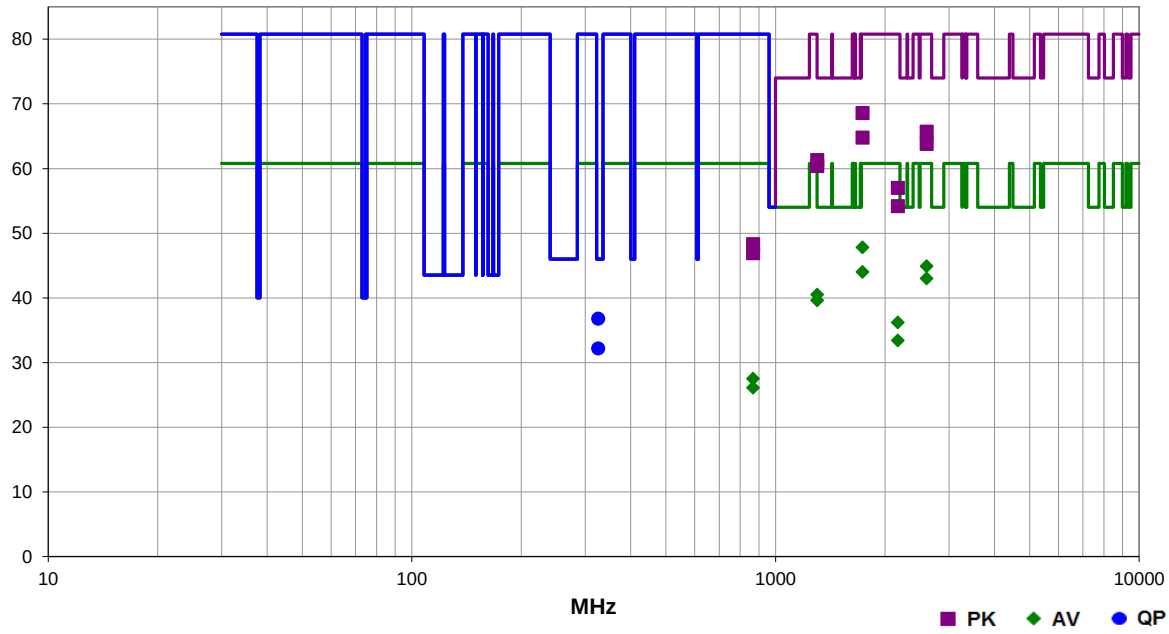
SPURIOUS RADIATED EMISSIONS

EmiR5 2020.04.20.0 PSA-ESCI 2020.04.03.0

Work Order:	CINC0052	**Date:**	2020-06-01		
Project:	None	**Temperature:**	23.1 °C		
Job Site:	MN05	**Humidity:**	45.2% RH		
Serial Number:	2090414	**Barometric Pres.:**	1015 mbar	**Tested by:**	Dustin Sparks
EUT:	RF-Water-433-CLR				
Configuration:	11				
Customer:	CINCH Systems				
Attendees:	Jibril Aga				
EUT Power:	Battery				
Operating Mode:	Transmitting 433.95 MHz CW				
Deviations:	None				
Comments:	The emission at 325.43 MHz (in FCC 15.205 restricted band) was fully maximized using a peak detector. The EUT was then replaced with the normal pulsed operation unit (SN 741138, configuration CINC0052-12) and quasi-peak points were taken using the worst-case orientation for both horizontal and vertical receive antenna polarities. The peak measurements were excluded from this document because they are not needed to meet the requirements of FCC 15.205.				

Test Specifications	**Test Method**
FCC 15.231:2020	ANSI C63.10:2013

Run #	21	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
325.430	38.3	-1.5	1.0	329.0		0.0	Horz	QP	0.0	36.8	46.0	-9.2	EUT on side
1735.700	74.1	-5.5	1.0	84.9		0.0	Horz	PK	0.0	68.6	80.8	-12.2	EUT on side
1301.908	67.9	-6.6	1.2	202.0		0.0	Vert	PK	0.0	61.3	74.0	-12.7	EUT vertical
1735.700	74.1	-5.5	1.0	84.9	-20.8	0.0	Horz	AV	0.0	47.8	60.8	-13.0	EUT on side
1301.908	67.9	-6.6	1.2	202.0	-20.8	0.0	Vert	AV	0.0	40.5	54.0	-13.5	EUT vertical
1301.875	67.0	-6.6	1.2	281.0		0.0	Horz	PK	0.0	60.4	74.0	-13.6	EUT on side
325.430	33.7	-1.5	1.3	285.8		0.0	Vert	QP	0.0	32.2	46.0	-13.8	EUT vertical
1301.875	67.0	-6.6	1.2	281.0	-20.8	0.0	Horz	AV	0.0	39.6	54.0	-14.4	EUT on side
2603.825	68.7	-3.0	1.1	30.0		0.0	Vert	PK	0.0	65.7	80.8	-15.1	EUT on side
2603.825	68.7	-3.0	1.1	30.0	-20.8	0.0	Vert	AV	0.0	44.9	60.8	-15.9	EUT on side
1735.775	70.3	-5.5	1.2	120.9		0.0	Vert	PK	0.0	64.8	80.8	-16.0	EUT vertical
1735.775	70.3	-5.5	1.2	120.9	-20.8	0.0	Vert	AV	0.0	44.0	60.8	-16.8	EUT vertical
2603.883	66.8	-3.0	2.7	224.0		0.0	Horz	PK	0.0	63.8	80.8	-17.0	EUT vertical
2603.883	66.8	-3.0	2.7	224.0	-20.8	0.0	Horz	AV	0.0	43.0	60.8	-17.8	EUT vertical
2169.583	59.7	-2.7	1.1	36.0		0.0	Horz	PK	0.0	57.0	80.8	-23.8	EUT on side
2169.583	59.7	-2.7	1.1	36.0	-20.8	0.0	Horz	AV	0.0	36.2	60.8	-24.6	EUT on side

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
2169.858	56.9	-2.7	1.2	33.0		0.0	Vert	PK	0.0	54.2	80.8	-26.6	EUT vertical
2169.858	56.9	-2.7	1.2	33.0	-20.8	0.0	Vert	AV	0.0	33.4	60.8	-27.4	EUT vertical
867.914	35.7	12.6	1.0	258.9		10.0	Horz	PK	0.0	48.3	80.8	-32.5	EUT on side
867.914	35.7	12.6	1.0	258.9	-20.8	10.0	Horz	AV	0.0	27.5	60.8	-33.3	EUT on side
867.899	34.3	12.6	1.5	40.0		10.0	Vert	PK	0.0	46.9	80.8	-33.9	EUT vertical
867.899	34.3	12.6	1.5	40.0	-20.8	10.0	Vert	AV	0.0	26.1	60.8	-34.7	EUT vertical

OCCUPIED BANDWIDTH

XMit 2020.03.25.0

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
Cable	ESM Cable Corp.	Bilog Cables	MNH	18-Oct-19	18-Oct-20
Antenna - Biconilog	ETS Lindgren	3142D	AXO	3-Sep-19	3-Sep-21
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	14-Apr-20	14-Apr-21

TEST DESCRIPTION

The EUT was transmitting at its maximum data rate.

The 20 dB occupied bandwidth is required to be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. 0.0025*433.950 MHz = 1085 kHz.

OCCUPIED BANDWIDTH

XMit 2020.03.25.0

EUT:	**RF-Water-433-CLR**			**Work Order:**	**CINC0052**
Serial Number:	**438673**			**Date:**	**1-Jun-20**
Customer:	**CINCH Systems**			**Temperature:**	**25.3 °C**
Attendees:	**Jibril Aga**			**Humidity:**	**48.5% RH**
Project:	**None**			**Barometric Pres.:**	**1013 mbar**
Tested by:	**Dustin Sparks**	**Power:**	**Battery**	**Job Site:**	**MN05**

TEST SPECIFICATIONS	**Test Method**
FCC 15.231:2020	ANSI C63.10:2013

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

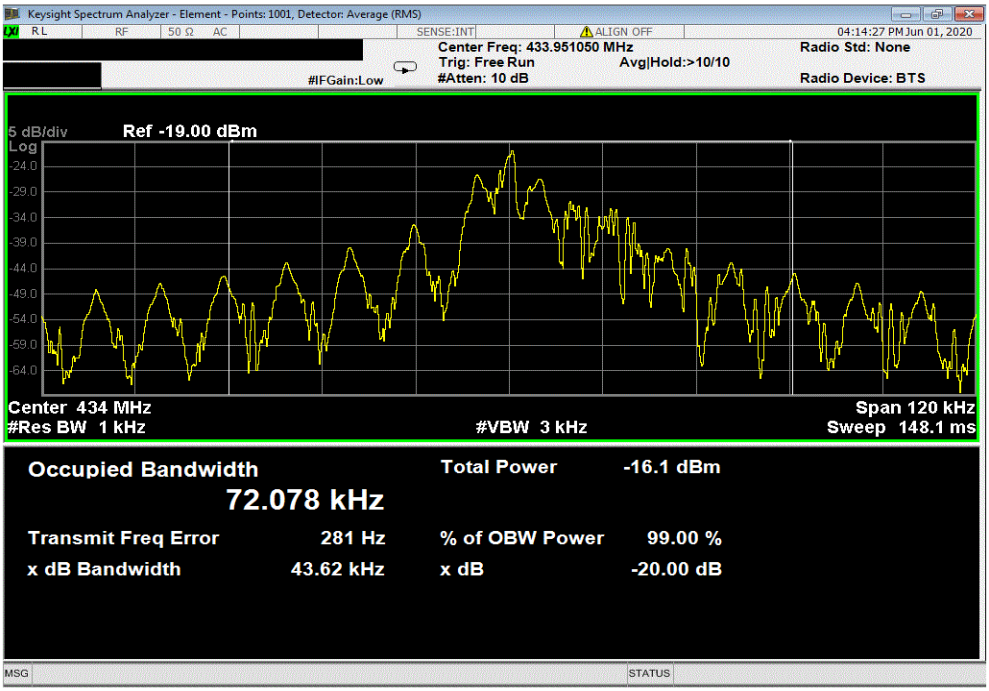
Configuration #	**13**	*Signature* Dustin Sparks

	Value (kHz)	**Limit (kHz)**	**Result**
433.95 MHz Periodic			
Occupied Bandwidth	43.62	1085	Pass

OCCUPIED BANDWIDTH

XMit 2020.03.25.0

433.95 MHz Periodic, Occupied Bandwidth						
				Value (kHz)	Limit (kHz)	Result
				43.62	1085	Pass



DUTY CYCLE

XMit 2020.03.25.0

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
Cable	ESM Cable Corp.	Bilog Cables	MNH	18-Oct-19	18-Oct-20
Antenna - Biconilog	ETS Lindgren	3142D	AXO	3-Sep-19	3-Sep-21
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	14-Apr-20	14-Apr-21

TEST DESCRIPTION

For software controlled or pre-programmed devices, the manufacturer shall declare the duty cycle class or classes for the equipment under test. For manually operated or event dependant devices, with or without software controlled functions, the manufacturer shall declare whether the device once triggered, follows a pre-programmed cycle, or whether the transmission is constant until the trigger is released or manually reset. The manufacturer shall also give a description of the application for the device and include a typical usage pattern. The typical usage pattern as declared by the manufacturer shall be used to determine the duty cycle and hence the duty class.

Where an acknowledgement is required, the additional transmitter on-time shall be included and declared by the manufacturer.

To derive average emission measurements, a duty cycle correction factor was utilized:

Duty Cycle = On time/100 milliseconds (or the period, whichever is less)

Where “On time” = N1L1 +N2L2 +….

Where N1 is the number of type 1 pulses, L1 is length of type 1 pulses, N2 is the number of type 2 pulses, L2 is the length of type 2 pulses, etc.

Therefore, Duty Cycle = (N1L1 +N2L2 +…)/100mS or T, whichever is less. (Where T is the period of the pulse train.)

The measured values for the EUT’s pulse train are as follows:

Period = 100 mSec
Pulsewidth of Type 1 Pulse = 0.0947 mSec
Pulsewidth of Type 2 Pulse = 0.208 mSec
Number of Type 1 Pulses = 46
Number of Type 2 Pulses = 23

Duty Cycle Correction Factor = 20 log [((0.0947)(46) + (0.208)(23))/100] = -20.8 dB

The duty cycle correction factor of -20.8 dB was added to the peak readings to mathematically derive the average levels. Peak measurements were made with a resolution bandwidth of 100kHz and a video bandwidth of 100kHz.

DUTY CYCLE

element

XMit 2020.03.25.0

EUT:	**RF-Water-433-CLR**			**Work Order:**	**CINC0052**
Serial Number:	**741138**			**Date:**	**1-Jun-20**
Customer:	**CINCH Systems**			**Temperature:**	**25.1 °C**
Attendees:	**Jibril Aga**			**Humidity:**	**47.2% RH**
Project:	**None**			**Barometric Pres.:**	**1013 mbar**
Tested by:	**Dustin Sparks**	**Power:**	**Battery**	**Job Site:**	**MN05**

TEST SPECIFICATIONS	**Test Method**
FCC 15.231:2020	ANSI C63.10:2013

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

Configuration #	**12**	*Signature* Dustin Sparks

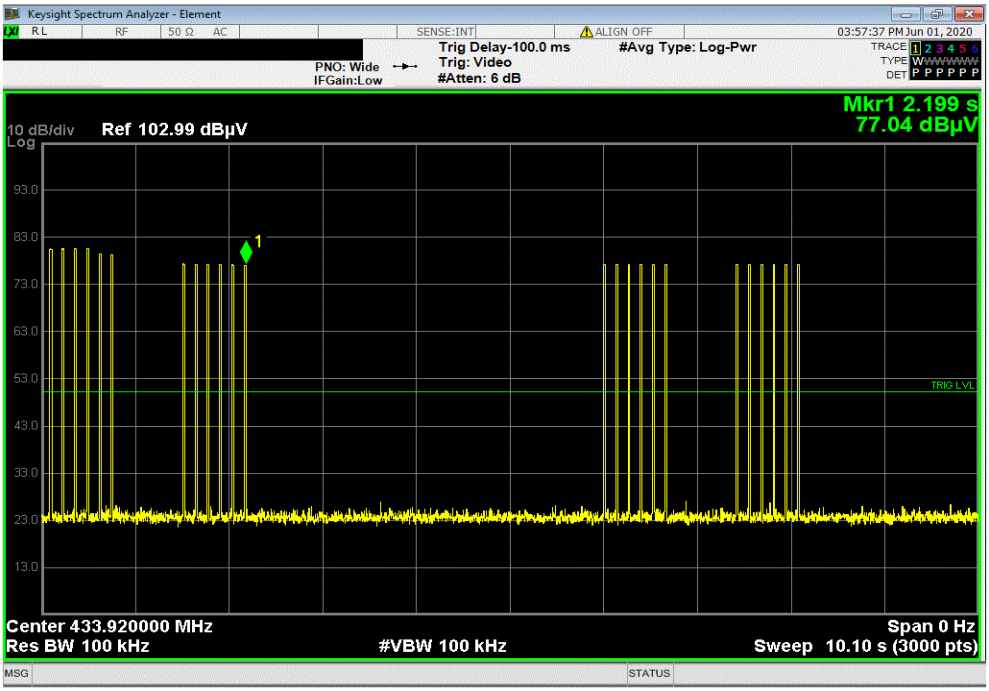
	Type 1 Pulse Width (ms)	Type 1 Pulse Count	Type 2 Pulse Width (ms)	Type 2 Pulse Count	On Time in 100 ms	DCCF (dB)	Result
433.95 MHz Periodic							
10 s Sweep	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 s Sweep	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100 ms Sweep	N/A	N/A	N/A	N/A	N/A	N/A	N/A
20 ms Sweep	0.0947	46	0.208	23	9.1402	-20.8	N/A

DUTY CYCLE

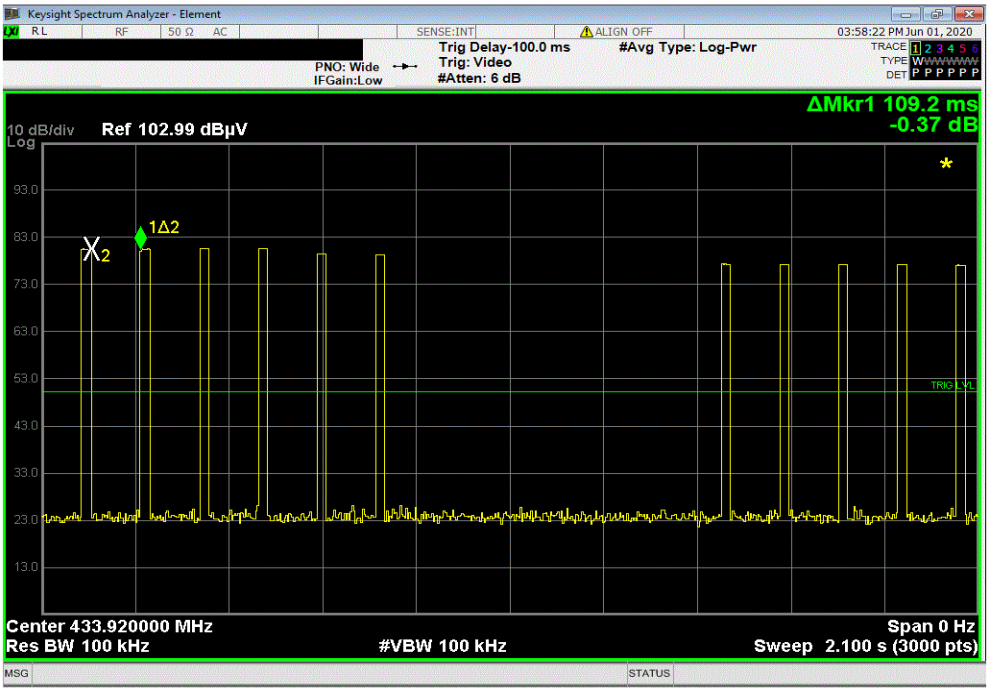
element

XMit 2020.03.25.0

433.95 MHz Periodic, 20 s Sweep						
Type 1 Pulse Width (ms)	Type 1 Pulse Count	Type 2 Pulse Width (ms)	Type 2 Pulse Count	On Time in 100 ms	DCCF (dB)	Result
N/A	N/A	N/A	N/A	N/A	N/A	N/A



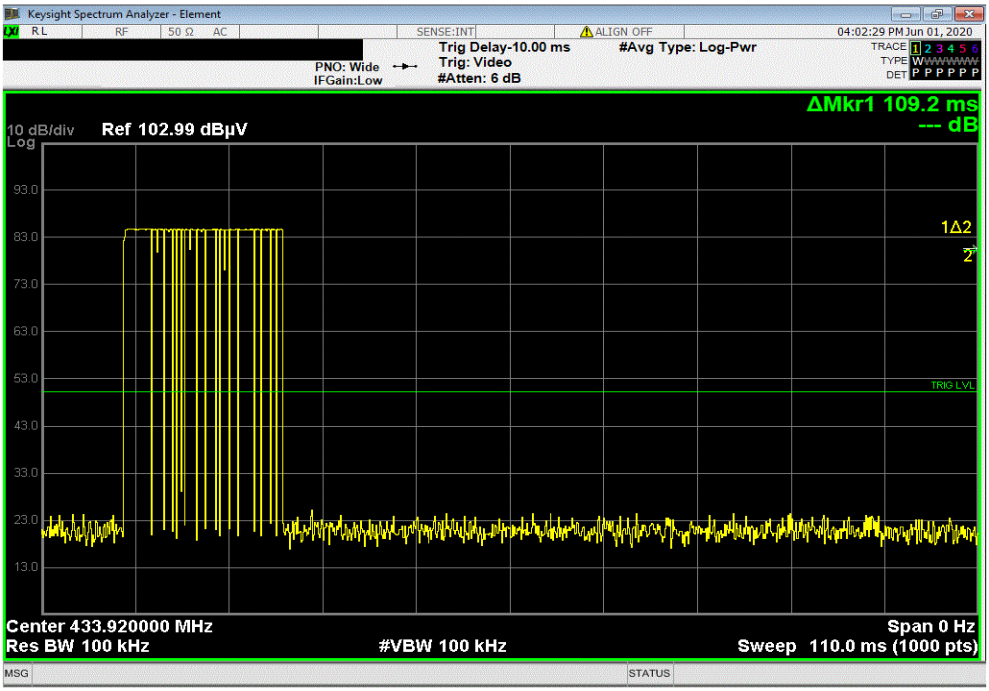
433.95 MHz Periodic, 2 s Sweep						
Type 1 Pulse Width (ms)	Type 1 Pulse Count	Type 2 Pulse Width (ms)	Type 2 Pulse Count	On Time in 100 ms	DCCF (dB)	Result
N/A	N/A	N/A	N/A	N/A	N/A	N/A



DUTY CYCLE

XMit 2020.03.25.0

433.95 MHz Periodic, 100 ms Sweep						
Type 1 Pulse Width (ms)	Type 1 Pulse Count	Type 2 Pulse Width (ms)	Type 2 Pulse Count	On Time in 100 ms	DCCF (dB)	Result
N/A	N/A	N/A	N/A	N/A	N/A	N/A



433.95 MHz Periodic, 20 ms Sweep						
Type 1 Pulse Width (ms)	Type 1 Pulse Count	Type 2 Pulse Width (ms)	Type 2 Pulse Count	On Time in 100 ms	DCCF (dB)	Result
0.0947	46	0.208	23	9.1402	-20.8	N/A