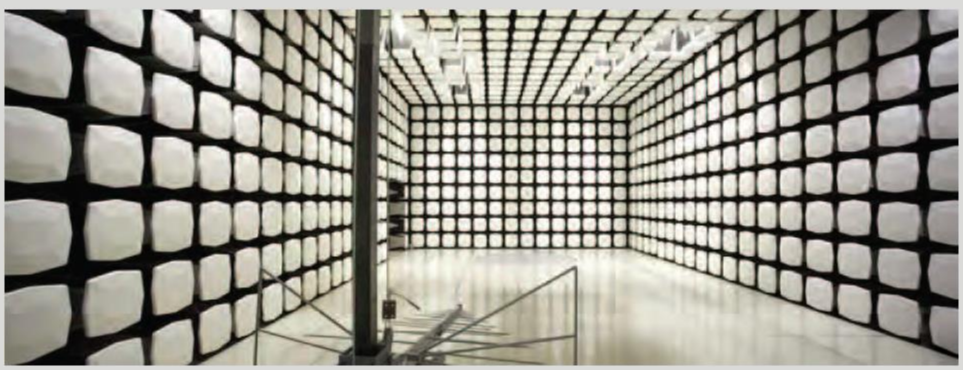
OPTEX Co., Ltd.

OVS-02 Series

FCC 15.249:2023

24.0-24.25 GHz Radio

Report: OPCO0004.0 Rev. 1, Issue Date: July 21, 2023



CERT #3310.02

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Section	Page Number

CERTIFICATE OF TEST

Last Date of Test: June 9, 2023
OPTEX Co., Ltd.
EUT: OVS-02 Series

Radio Equipment Testing

Standards

Specification	Method
FCC 15.207:2023	ANSI C63.10:2013
FCC 15.249:2023	

Results

Test Description	Result	Specification Section(s)	Method Section(s)	Comments
Powerline Conducted Emissions	Pass	15.207	6.2	
Field Strength of Harmonics and Spurious Radiated Emissions	Pass	15.249(a),(c-e)	6.5, 6.6	
Field Strength of Fundamental	Pass	15.249(a),(c-e)	6.6	
Frequency Stability	N/A	15.31(e), 15.215(c), 2.1055	6.8	Not required to test unless the radio is a fixed point to point device
Occupied Bandwidth	Pass	15.215(c)	6.9.2	
Antenna Beamwidth	N/A	15.249(b)(3)	6.6	Not required unless the EUT is intended for fixed point-to-point operation
Duty Cycle	Pass	N/A	7.5	

Deviations From Test Standards

None

Approved By:

Cole Ghizzone, 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
01	Updated the labeling naming for pulse 1 and pulse 2	2023-07-21	40
	revise the frequency range of operation for consistency: Updated FF to: 24.04-24.24 Updated SRE to: 24.04-24.24 Updated AC to: 24.04-24.24	2023-07-21	15, 25, 33
	Added 'Sensor Program ver.0.3.33' to antenna and power settings.	2023-07-21	12
	Updated the model to OVS-02GT(BL) to the configurations.	2023-07-21	13
	Header spelling error corrected.	2023-07-21	24-31
	Added values for xdB f_low and xdB f_high, and a limit showing that the xdB BW is contained in the allowable band.	2023-07-21	37-38

ACCREDITATIONS AND AUTHORIZATIONS

2021.09.01

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 - Each laboratory is accredited by A2LA to ISO / IEC 17025, and as a product certifier to ISO / IEC 17065 which allows Element to certify transmitters to FCC and IC specifications.

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 – Recognized as an EU Notified Body validated for the EMCD and RED Directives.

United Kingdom

BEIS – Recognized by the UK as an Approved Body under the UK Radio Equipment and UK EMC Regulations.

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.

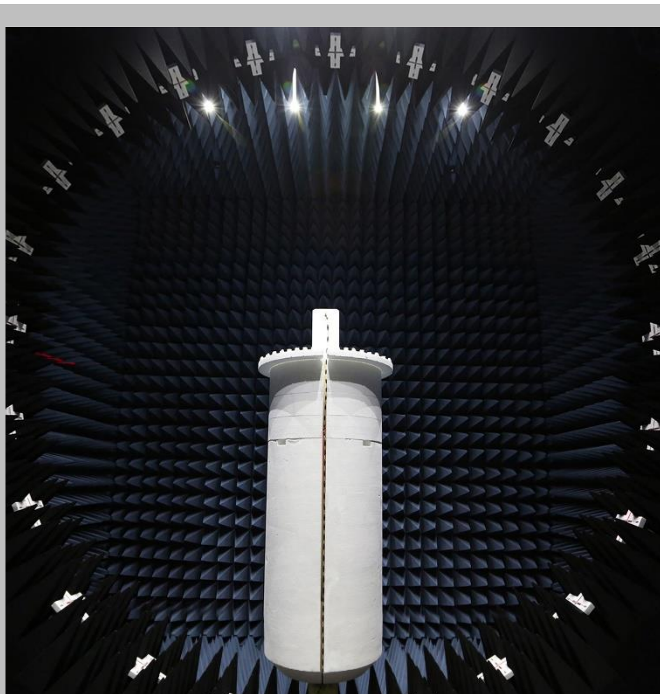
SCOPE

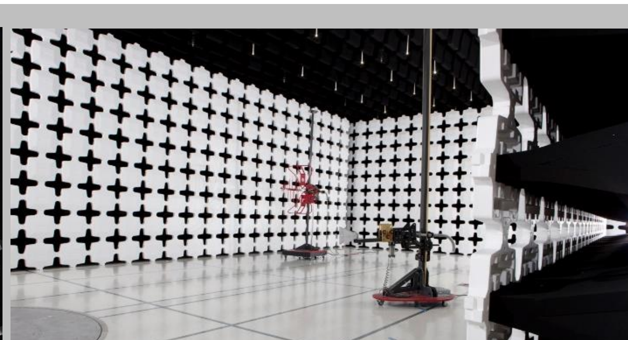
For details on the Scopes of our Accreditations, please visit:

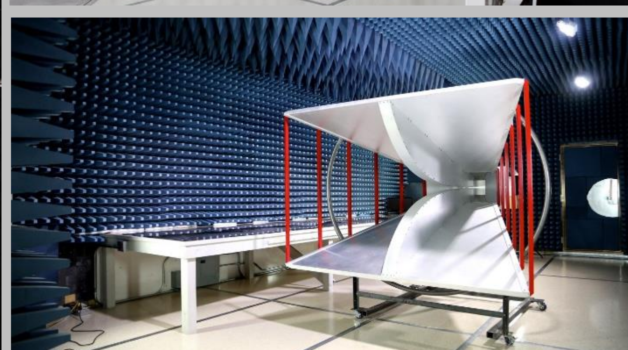
California Minnesota Oregon Texas Washington

FACILITIES

California Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	**Minnesota** Labs MN01-11 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612) 638-5136	**Oregon** Labs EV01-12 6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	**Texas** Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	**Washington** Labs NC01-05 19201 120th Ave NE Bothell, WA 98011 (425) 984-6600
A2LA				
Lab Code: 3310.04	Lab Code: 3310.05	Lab Code: 3310.02	Lab Code: 3310.03	Lab Code: 3310.06
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

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 in the table below. A lab specific value may also be found in the applicable test description section. 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)	3.2 dB	-3.2 dB

TEST SETUP BLOCK DIAGRAMS

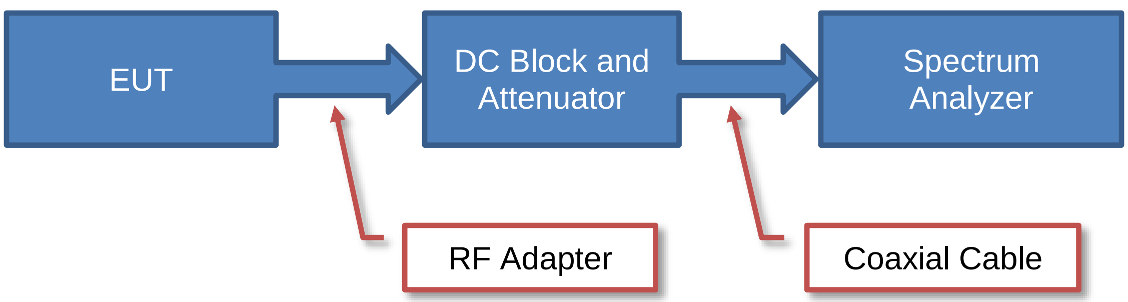
2022.04.22

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

Unless otherwise stated, measurements were made using the bandwidths and detectors specified. No video filter was used.

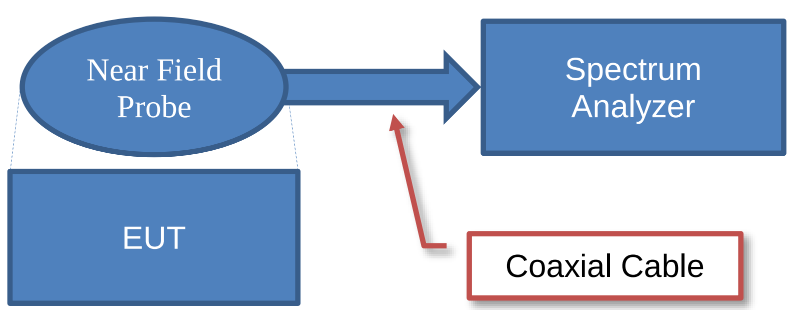
Antenna Port Conducted Measurements



Sample Calculation (logarithmic units)

Measured Value		Measured Level		Reference Level Offset
71.2	=	42.6	+	28.6

Near Field Test Fixture Measurements

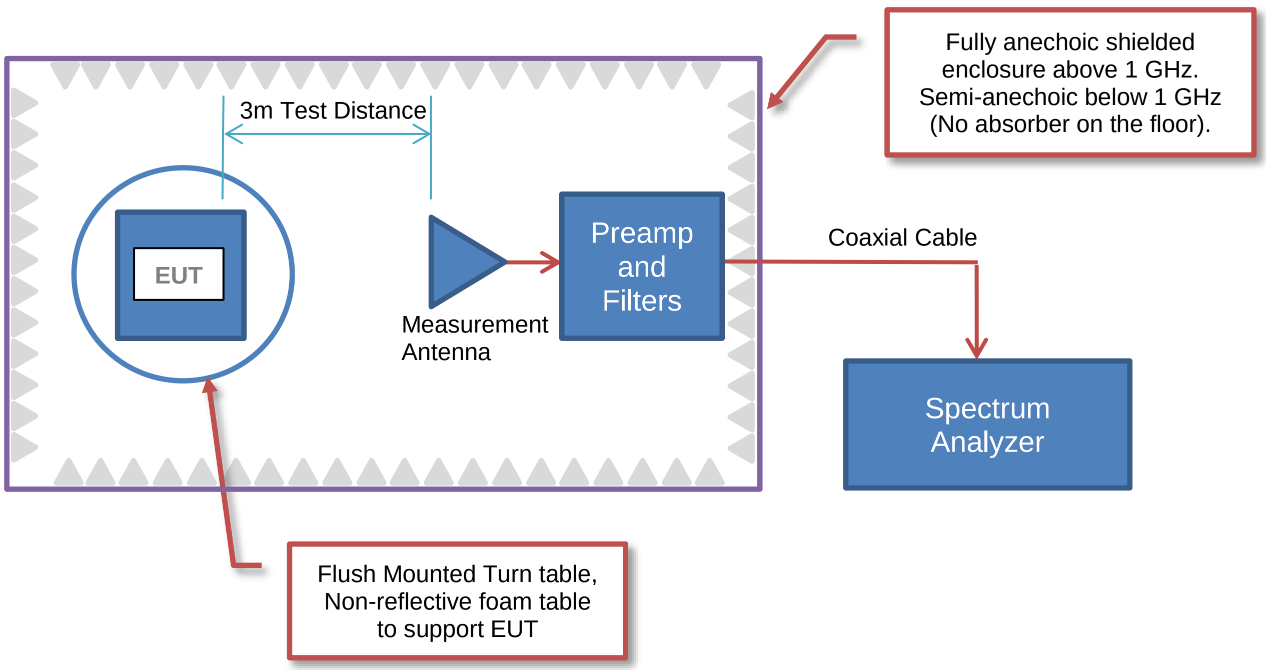


Sample Calculation (logarithmic units)

Measured Value		Measured Level		Reference Level Offset
71.2	=	42.6	+	28.6

TEST SETUP BLOCK DIAGRAMS

Emissions Measurements



Sample Calculation (logarithmic units)

Radiated Emissions:

Measured Level (Amplitude)		Factor: Antenna Factor		Factor: Cable Factor		Factor: Amplifier Gain		Distance Adjustment Factor		External Attenuation		Field Strength
42.6	+	28.6	+	3.1	-	40.8	+	0.0	+	0.0	=	**33.5**

Conducted Emissions:

Measured Level (Amplitude)		Factor: Transducer Factor		Factor: Cable Factor		External Attenuation		Adjusted Level
26.7	+	0.3	+	0.1	+	20.0	=	**47.1**

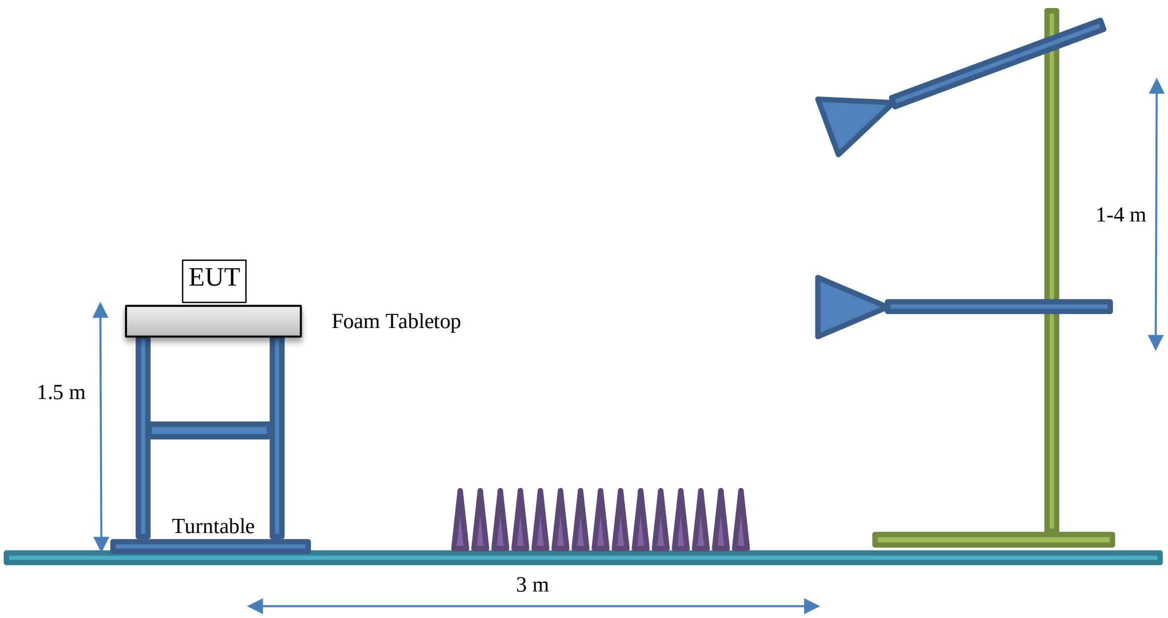
Radiated Power (ERP/EIRP) – Substitution Method:

Measured Level into Substitution Antenna (Amplitude dBm)		Substitution Antenna Factor (dBi)		EIRP to ERP (if applicable)		Measured power (dBm ERP/EIRP)
10.0	+	6.0	-	2.15	=	**13.9/16.0**

TEST SETUP BLOCK DIAGRAMS

Bore Sighting (>1GHz)

The diameter of the illumination area is the dimension of the line tangent to the EUT formed by 3 dB beamwidth of the measurement antenna at the measurement distance. At a 3 meter test distance, the diameter of the illumination area was 3.8 meters at 1 GHz and greater than 2.1 meters up to 6 GHz. Above 1 GHz, when required by the measurement standard, the antenna is pointed for both azimuth and elevation to maintain the receive antenna within the cone of radiation from the EUT. The specified measurement detectors were used for comparison of the emissions to the peak and average specification limits.



PRODUCT DESCRIPTION

Client and Equipment under Test (EUT) Information

Company Name:	OPTEX Co., Ltd.
Address:	5-8-12
City, State, Zip:	Ogoto Otsu, 520-0101, Japan
Test Requested By:	Toshiyasu Matsuyama
EUT:	OVS-02 Series
First Date of Test:	June 7, 2023
Last Date of Test:	June 9, 2023
Receipt Date of Samples:	June 7, 2023
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
24 GHz Sensor

Testing Objective:
Seeking to demonstrate compliance under FCC 15.249:2023 for operation in the 24.0-24.25 GHz General usage (FCC 15.249), Band.

POWER SETTINGS AND ANTENNAS

The power settings, antenna gain value(s) and cable loss (if applicable) used for the testing contained in this report were provided by the customer and will affect the validity of the results. Element assumes no responsibility for the accuracy of this information. The power settings below reflect the maximum power that the EUT is allowed to transmit at during normal operation.

ANTENNA GAIN (dBi)

Type	Provided by:	Frequency Range (GHz)	Gain (dBi)
Patch antenna array	InnoSent	24 – 24.25	11

The EUT was tested using the power settings provided by the manufacturer which were based upon:

☐ Test software settings Test software/firmware installed on EUT: Sensor Program ver.0.3.33
x Rated power settings

SETTINGS FOR ALL TESTS IN THIS REPORT

Modulation Types	Frequency (GHz)	Power Setting (dBm)
FMCW	24.04 – 24.24	4

CONFIGURATIONS

Configuration OPCO0004-2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
OVS-02 Series	OPTEX Co, Ltd	OVS-02GT(BL)	50

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
DC Power Cable	No	2 m	No	OVS-02 Series	DC Power Supply

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2023-06-07	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	2023-06-08	Duty Cycle	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	2023-06-08	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	2023-06-08	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	2023-06-09	Field Strength Of Harmonics And Spurious Radiated 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.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

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	Gauss Instruments	TDEMI 30M	ARN	2023-05-08	2024-05-08
LISN	Solar Electronics	9252-50-R-24-BNC	LIP	2022-09-08	2023-09-08
Cable - Conducted Cable Assembly	Northwest EMC	EVG, HHD, RKT, VAB	EVGA	2023-05-16	2024-05-16
Power Supply - DC	Topward	TPS-2000	TPD	NCR	NCR

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	3.2 dB	-3.2 dB

CONFIGURATIONS INVESTIGATED

OPCO0004-2

MODES INVESTIGATED

FMCW: 24.04 - 24.24 GHz

POWERLINE CONDUCTED EMISSIONS

WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

EUT:	OVS-02 Series	Work Order:	OPCO0004
Serial Number:	50	Date:	2023-06-08
Customer:	OPTEX Co., Ltd.	Temperature:	22.9°C
Attendees:	None	Relative Humidity:	45.3%
Customer Project:	None	Bar. Pressure (PMSL):	1014 mb
Tested By:	Jeff Alcoke	Job Site:	EV07
Power:	12 VDC Via 110VAC/60Hz	Configuration:	OPCO0004-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2023	ANSI C63.10:2013

TEST PARAMETERS

Run #:	1	Line:	High Line	Add. Ext. Attenuation (dB):	0

COMMENTS

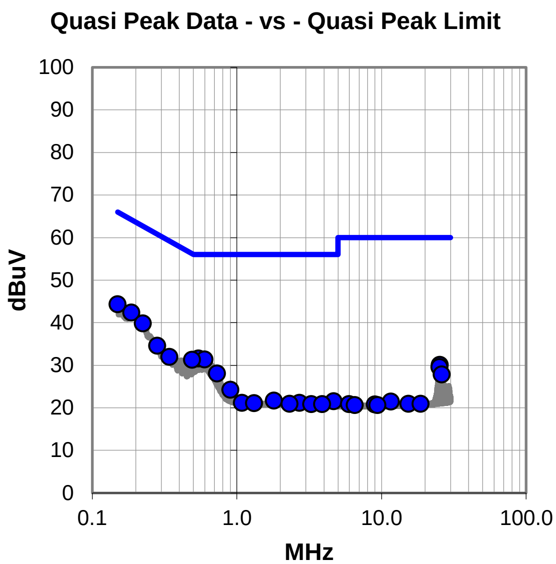
Measuring AC Mains of DC power supply.

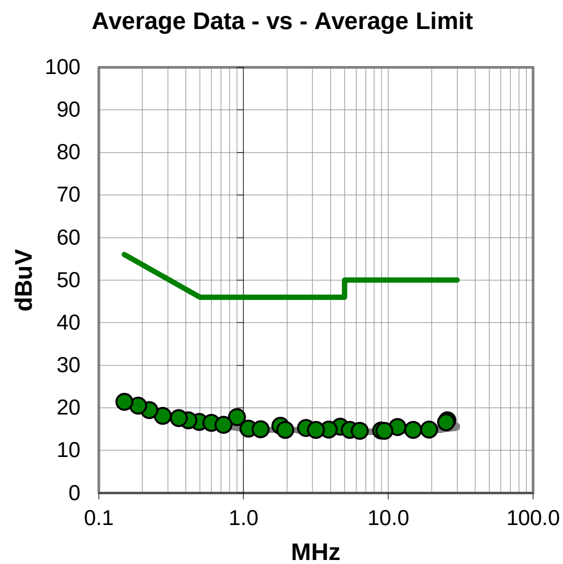
EUT OPERATING MODES

FMCW: 24.04 - 24.24 GHz

DEVIATIONS FROM TEST STANDARD

None





POWERLINE CONDUCTED EMISSIONS

WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #1

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.150	24.3	20.1	44.4	66.0	-21.6
0.187	22.4	20.0	42.4	64.2	-21.8
0.223	19.9	20.0	39.9	62.7	-22.8
0.544	11.8	19.8	31.6	56.0	-24.4
0.599	11.5	19.9	31.4	56.0	-24.6
0.489	11.5	19.8	31.3	56.2	-24.9
0.281	14.6	20.0	34.6	60.8	-26.2
0.341	12.1	19.9	32.0	59.2	-27.2
0.727	8.2	19.9	28.1	56.0	-27.9
25.327	8.9	21.2	30.1	60.0	-29.9
25.144	8.4	21.2	29.6	60.0	-30.4
0.902	4.4	19.9	24.3	56.0	-31.7
26.087	6.7	21.2	27.9	60.0	-32.1
1.802	1.6	20.1	21.7	56.0	-34.3
4.656	1.4	20.2	21.6	56.0	-34.4
1.084	1.3	19.9	21.2	56.0	-34.8
2.703	1.1	20.1	21.2	56.0	-34.8
1.316	1.1	20.0	21.1	56.0	-34.9
2.318	0.9	20.1	21.0	56.0	-35.0
3.270	0.7	20.2	20.9	56.0	-35.1
3.879	0.7	20.2	20.9	56.0	-35.1
11.587	0.9	20.6	21.5	60.0	-38.5
15.359	0.2	20.8	21.0	60.0	-39.0
18.605	0.1	20.9	21.0	60.0	-39.0
5.948	0.6	20.3	20.9	60.0	-39.1

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.902	-2.1	19.9	17.8	46.0	-28.2
0.493	-3.1	19.8	16.7	46.1	-29.4
0.599	-3.4	19.9	16.5	46.0	-29.5
0.727	-3.9	19.9	16.0	46.0	-30.0
1.802	-4.3	20.1	15.8	46.0	-30.2
0.415	-2.8	19.9	17.1	47.5	-30.4
4.654	-4.6	20.2	15.6	46.0	-30.4
2.704	-4.8	20.1	15.3	46.0	-30.7
1.082	-4.8	19.9	15.1	46.0	-30.9
1.311	-5.0	20.0	15.0	46.0	-31.0
3.878	-5.3	20.2	14.9	46.0	-31.1
0.356	-2.3	19.9	17.6	48.8	-31.2
1.943	-5.3	20.1	14.8	46.0	-31.2
3.159	-5.4	20.2	14.8	46.0	-31.2
0.277	-1.9	20.0	18.1	50.9	-32.8
25.602	-4.1	21.2	17.1	50.0	-32.9
0.223	-0.5	20.0	19.5	52.7	-33.2
25.126	-4.6	21.2	16.6	50.0	-33.4
0.187	0.5	20.0	20.5	54.2	-33.7
11.587	-5.1	20.6	15.5	50.0	-34.5
0.150	1.3	20.1	21.4	56.0	-34.6
19.137	-6.0	20.9	14.9	50.0	-35.1
5.429	-5.5	20.3	14.8	50.0	-35.2
14.868	-6.0	20.8	14.8	50.0	-35.2
8.937	-5.8	20.5	14.7	50.0	-35.3

CONCLUSION

Pass

Tested By

POWERLINE CONDUCTED EMISSIONS

EUT:	OVS-02 Series	Work Order:	OPCO0004
Serial Number:	50	Date:	2023-06-08
Customer:	OPTEX Co., Ltd.	Temperature:	22.9°C
Attendees:	None	Relative Humidity:	45.3%
Customer Project:	None	Bar. Pressure (PMSL):	1014 mb
Tested By:	Jeff Alcoke	Job Site:	EV07
Power:	12 VDC Via 110VAC/60Hz	Configuration:	OPCO0004-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2023	ANSI C63.10:2013

TEST PARAMETERS

Run #:	2	Line:	Neutral	Add. Ext. Attenuation (dB):	0

COMMENTS

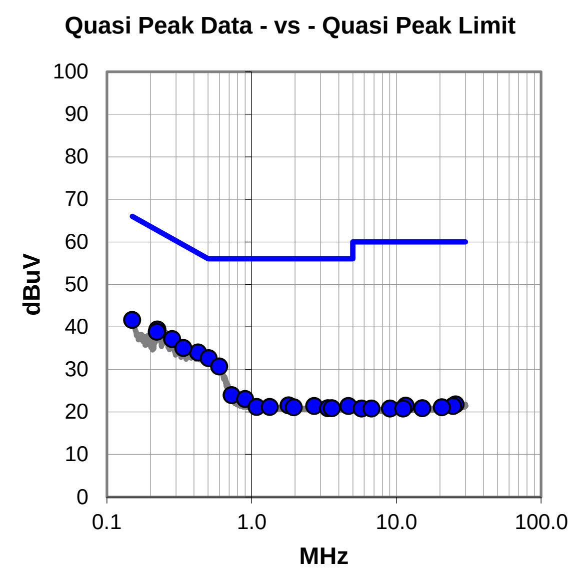
Measuring AC Mains of DC power supply.

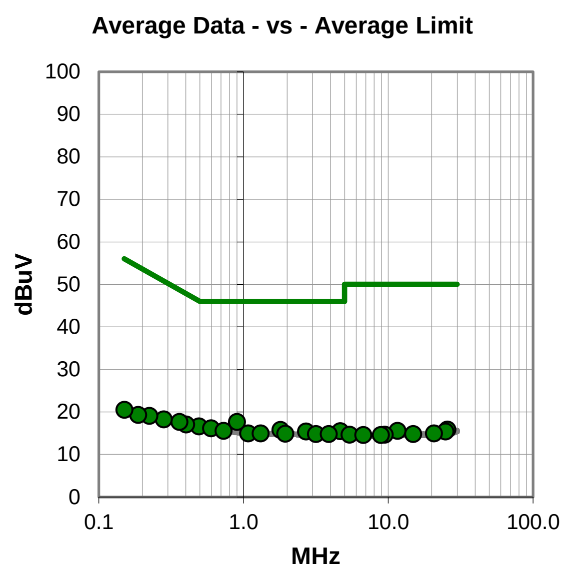
EUT OPERATING MODES

FMCW: 24.04 - 24.24 GHz

DEVIATIONS FROM TEST STANDARD

None





POWERLINE CONDUCTED EMISSIONS

WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #2

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.426	14.1	19.9	34.0	57.3	-23.3
0.506	12.9	19.8	32.7	56.0	-23.3
0.223	19.4	20.0	39.4	62.7	-23.3
0.283	17.2	20.0	37.2	60.7	-23.5
0.222	18.9	20.0	38.9	62.8	-23.9
0.338	15.2	19.9	35.1	59.3	-24.2
0.150	21.6	20.1	41.7	66.0	-24.3
0.597	10.8	19.9	30.7	56.0	-25.3
0.727	4.1	19.9	24.0	56.0	-32.0
0.901	3.2	19.9	23.1	56.0	-32.9
1.805	1.5	20.1	21.6	56.0	-34.4
2.704	1.3	20.1	21.4	56.0	-34.6
4.656	1.2	20.2	21.4	56.0	-34.6
1.081	1.3	19.9	21.2	56.0	-34.8
1.336	1.2	20.0	21.2	56.0	-34.8
1.960	1.0	20.1	21.1	56.0	-34.9
3.362	0.7	20.2	20.9	56.0	-35.1
3.577	0.7	20.2	20.9	56.0	-35.1
25.602	0.6	21.2	21.8	60.0	-38.2
11.587	0.9	20.6	21.5	60.0	-38.5
24.696	0.2	21.2	21.4	60.0	-38.6
20.623	0.1	21.0	21.1	60.0	-38.9
15.121	0.1	20.8	20.9	60.0	-39.1
5.750	0.5	20.3	20.8	60.0	-39.2
6.725	0.5	20.3	20.8	60.0	-39.2

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.902	-2.2	19.9	17.7	46.0	-28.3
0.492	-3.2	19.8	16.6	46.1	-29.5
0.597	-3.7	19.9	16.2	46.0	-29.8
1.802	-4.3	20.1	15.8	46.0	-30.2
0.727	-4.3	19.9	15.6	46.0	-30.4
4.654	-4.7	20.2	15.5	46.0	-30.5
2.704	-4.7	20.1	15.4	46.0	-30.6
0.402	-2.8	19.9	17.1	47.8	-30.7
1.076	-4.9	19.9	15.0	46.0	-31.0
1.311	-5.0	20.0	15.0	46.0	-31.0
0.361	-2.2	19.9	17.7	48.7	-31.0
1.947	-5.2	20.1	14.9	46.0	-31.1
3.170	-5.4	20.2	14.8	46.0	-31.2
3.878	-5.4	20.2	14.8	46.0	-31.2
0.281	-1.7	20.0	18.3	50.8	-32.5
0.223	-0.9	20.0	19.1	52.7	-33.6
25.602	-5.3	21.2	15.9	50.0	-34.1
11.587	-5.0	20.6	15.6	50.0	-34.4
24.827	-5.8	21.2	15.4	50.0	-34.6
0.187	-0.7	20.0	19.3	54.2	-34.9
20.648	-6.0	21.0	15.0	50.0	-35.0
14.876	-6.0	20.8	14.8	50.0	-35.2
5.409	-5.6	20.3	14.7	50.0	-35.3
9.453	-5.8	20.5	14.7	50.0	-35.3
6.723	-5.7	20.3	14.6	50.0	-35.4

CONCLUSION

Pass

Tested By

POWERLINE CONDUCTED EMISSIONS

EUT:	OVS-02 Series	Work Order:	OPCO0004
Serial Number:	50	Date:	2023-06-08
Customer:	OPTEX Co., Ltd.	Temperature:	22.9°C
Attendees:	None	Relative Humidity:	45.3%
Customer Project:	None	Bar. Pressure (PMSL):	1014 mb
Tested By:	Jeff Alcoke	Job Site:	EV07
Power:	24 VDC Via 110VAC/60Hz	Configuration:	OPCO0004-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2023	ANSI C63.10:2013

TEST PARAMETERS

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

COMMENTS

Measuring AC Mains of DC power supply.

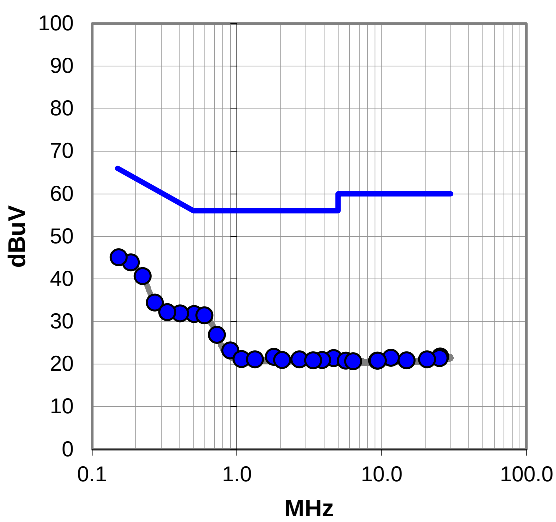
EUT OPERATING MODES

FMCW: 24.04 - 24.24 GHz

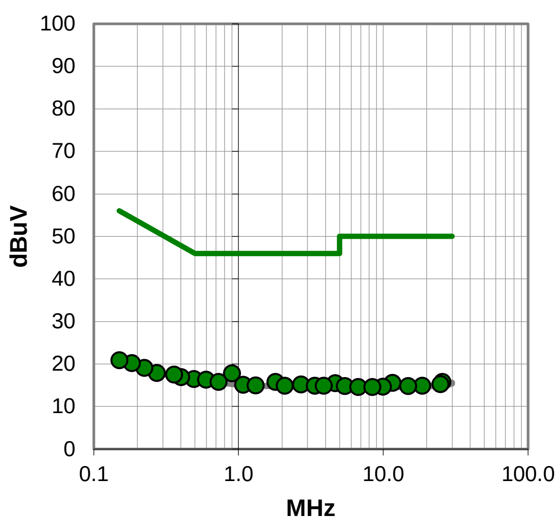
DEVIATIONS FROM TEST STANDARD

None

Quasi Peak Data - vs - Quasi Peak Limit



Average Data - vs - Average Limit



POWERLINE CONDUCTED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #3

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.185	23.9	20.0	43.9	64.3	-20.4
0.153	25.0	20.1	45.1	65.8	-20.7
0.223	20.7	20.0	40.7	62.7	-22.0
0.507	12.0	19.8	31.8	56.0	-24.2
0.597	11.6	19.9	31.5	56.0	-24.5
0.405	12.0	19.9	31.9	57.8	-25.9
0.272	14.5	20.0	34.5	61.1	-26.6
0.332	12.3	19.9	32.2	59.4	-27.2
0.727	7.0	19.9	26.9	56.0	-29.1
0.901	3.3	19.9	23.2	56.0	-32.8
1.802	1.6	20.1	21.7	56.0	-34.3
4.656	1.2	20.2	21.4	56.0	-34.6
1.079	1.3	19.9	21.2	56.0	-34.8
1.337	1.1	20.0	21.1	56.0	-34.9
2.703	1.0	20.1	21.1	56.0	-34.9
2.062	0.9	20.1	21.0	56.0	-35.0
3.876	0.8	20.2	21.0	56.0	-35.0
3.362	0.7	20.2	20.9	56.0	-35.1
25.343	0.6	21.2	21.8	60.0	-38.2
11.589	0.9	20.6	21.5	60.0	-38.5
25.112	0.2	21.2	21.4	60.0	-38.6
20.585	0.1	21.0	21.1	60.0	-38.9
14.869	0.1	20.8	20.9	60.0	-39.1
5.667	0.5	20.3	20.8	60.0	-39.2
9.345	0.3	20.5	20.8	60.0	-39.2

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.901	-2.1	19.9	17.8	46.0	-28.2
0.492	-3.3	19.8	16.5	46.1	-29.6
0.597	-3.6	19.9	16.3	46.0	-29.7
0.727	-4.1	19.9	15.8	46.0	-30.2
1.804	-4.3	20.1	15.8	46.0	-30.2
4.654	-4.7	20.2	15.5	46.0	-30.5
2.704	-4.9	20.1	15.2	46.0	-30.8
0.402	-3.0	19.9	16.9	47.8	-30.9
1.076	-4.8	19.9	15.1	46.0	-30.9
1.314	-5.0	20.0	15.0	46.0	-31.0
2.082	-5.2	20.1	14.9	46.0	-31.1
3.362	-5.3	20.2	14.9	46.0	-31.1
3.879	-5.3	20.2	14.9	46.0	-31.1
0.359	-2.4	19.9	17.5	48.8	-31.3
0.272	-2.1	20.0	17.9	51.1	-33.2
0.223	-0.9	20.0	19.1	52.7	-33.6
0.184	0.2	20.0	20.2	54.3	-34.1
25.600	-5.4	21.2	15.8	50.0	-34.2
11.589	-5.0	20.6	15.6	50.0	-34.4
24.827	-5.9	21.2	15.3	50.0	-34.7
0.150	0.8	20.1	20.9	56.0	-35.1
18.609	-6.0	20.9	14.9	50.0	-35.1
5.431	-5.5	20.3	14.8	50.0	-35.2
14.869	-6.0	20.8	14.8	50.0	-35.2
9.946	-5.8	20.5	14.7	50.0	-35.3

CONCLUSION

Pass

Tested By

POWERLINE CONDUCTED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

EUT:	OVS-02 Series	Work Order:	OPCO0004
Serial Number:	50	Date:	2023-06-08
Customer:	OPTEX Co., Ltd.	Temperature:	22.9°C
Attendees:	None	Relative Humidity:	45.3%
Customer Project:	None	Bar. Pressure (PMSL):	1014 mb
Tested By:	Jeff Alcoke	Job Site:	EV07
Power:	24 VDC Via 110VAC/60Hz	Configuration:	OPCO0004-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.207:2023	ANSI C63.10:2013

TEST PARAMETERS

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

COMMENTS

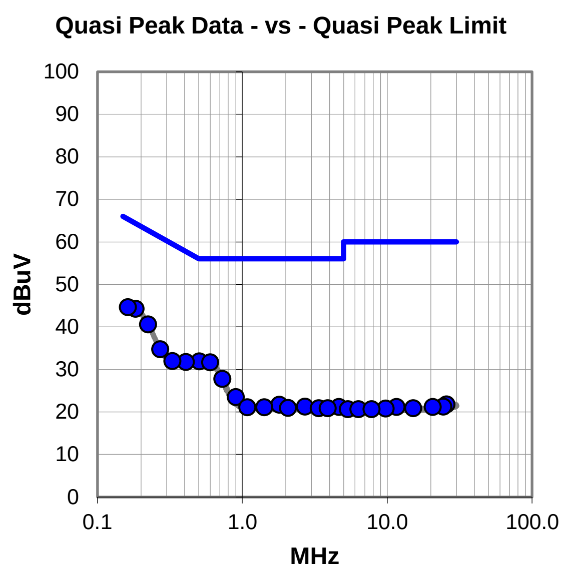
Measuring AC Mains of DC power supply.

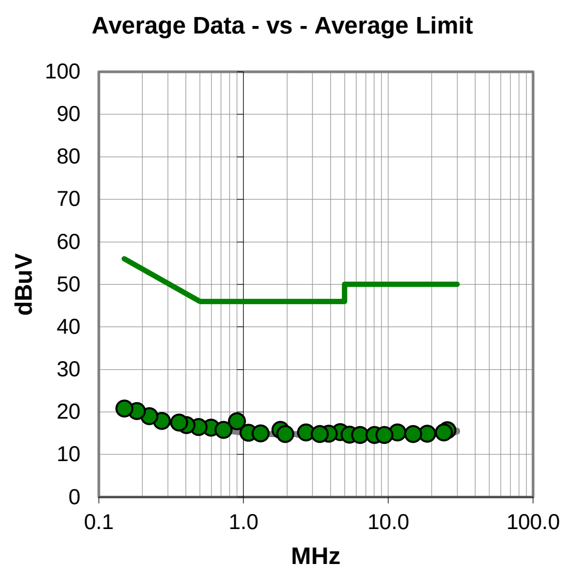
EUT OPERATING MODES

FMCW: 24.04 - 24.24 GHz

DEVIATIONS FROM TEST STANDARD

None





POWERLINE CONDUCTED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #4

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.184	24.3	20.0	44.3	64.3	-20.0
0.162	24.6	20.1	44.7	65.4	-20.7
0.223	20.6	20.0	40.6	62.7	-22.1
0.506	12.1	19.8	31.9	56.0	-24.1
0.600	11.8	19.9	31.7	56.0	-24.3
0.408	11.9	19.9	31.8	57.7	-25.9
0.272	14.8	20.0	34.8	61.1	-26.3
0.330	12.1	19.9	32.0	59.5	-27.5
0.728	7.9	19.9	27.8	56.0	-28.2
0.902	3.6	19.9	23.5	56.0	-32.5
1.802	1.6	20.1	21.7	56.0	-34.3
2.704	1.2	20.1	21.3	56.0	-34.7
4.654	1.0	20.2	21.2	56.0	-34.8
1.082	1.2	19.9	21.1	56.0	-34.9
1.418	1.1	20.0	21.1	56.0	-34.9
2.066	0.9	20.1	21.0	56.0	-35.0
3.363	0.7	20.2	20.9	56.0	-35.1
3.879	0.7	20.2	20.9	56.0	-35.1
25.602	0.6	21.2	21.8	60.0	-38.2
24.371	0.1	21.2	21.3	60.0	-38.7
11.587	0.6	20.6	21.2	60.0	-38.8
20.574	0.2	21.0	21.2	60.0	-38.8
15.127	0.1	20.8	20.9	60.0	-39.1
9.735	0.3	20.5	20.8	60.0	-39.2
5.359	0.5	20.2	20.7	60.0	-39.3

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.902	-2.1	19.9	17.8	46.0	-28.2
0.597	-3.6	19.9	16.3	46.0	-29.7
0.490	-3.3	19.8	16.5	46.2	-29.7
0.727	-4.1	19.9	15.8	46.0	-30.2
1.804	-4.3	20.1	15.8	46.0	-30.2
4.656	-4.9	20.2	15.3	46.0	-30.7
2.704	-4.9	20.1	15.2	46.0	-30.8
0.403	-3.0	19.9	16.9	47.8	-30.9
1.082	-4.8	19.9	15.1	46.0	-30.9
1.311	-5.0	20.0	15.0	46.0	-31.0
3.879	-5.3	20.2	14.9	46.0	-31.1
1.943	-5.3	20.1	14.8	46.0	-31.2
3.360	-5.4	20.2	14.8	46.0	-31.2
0.359	-2.4	19.9	17.5	48.8	-31.3
0.272	-2.1	20.0	17.9	51.1	-33.2
0.223	-1.0	20.0	19.0	52.7	-33.7
0.184	0.2	20.0	20.2	54.3	-34.1
25.602	-5.5	21.2	15.7	50.0	-34.3
11.587	-5.4	20.6	15.2	50.0	-34.8
24.210	-6.0	21.2	15.2	50.0	-34.8
18.588	-6.0	20.9	14.9	50.0	-35.1
0.150	0.7	20.1	20.8	56.0	-35.2
14.880	-6.0	20.8	14.8	50.0	-35.2
5.408	-5.6	20.3	14.7	50.0	-35.3
6.374	-5.7	20.3	14.6	50.0	-35.4

CONCLUSION

Pass

Tested By

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

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 frequencies and the modes as shown 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 axes, and adjusting the measurement antenna height and polarization (per ANSI C63.10). A preamp was used for this test to provide sufficient measurement sensitivity.

Above 40 GHz spectrum analyzer extenders were used to measure emissions. The spectrum analyzer was configured to account for measurement losses from the spectrum analyzer extenders and the cable between the extender and the analyzer at the intermediate frequency (IF).

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.

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

The PK measurements were corrected with an FMCW Factor as called out in ANSI C63.10:2020, Annex L, using the following equation:

$$\alpha = \frac{1}{\sqrt{1+\left(\frac{2\ln(2)}{\pi}\right)^2\left(\frac{BW_{\text{Chirp}}}{T_{\text{Chirp}}B^2}\right)^2}}$$

where

α	is the reduction in amplitude
BW_{Chirp}	is the FMCW Chirp Bandwidth
T_{Chirp}	is the FMCW Chirp Time
B	is the 3 dB IF Bandwidth = RBW

FMCW Factor (dB) = 10*log(α)

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Receiver	Rohde & Schwarz	ESCI	ARF	2022-09-26	2023-09-26
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFI	2022-12-19	2023-12-19
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	2022-09-08	2023-09-08
Antenna - Biconilog	EMCO	3141	AXG	2021-08-13	2023-08-13
Antenna - Double Ridge	ETS Lindgren	3115	AIZ	2022-03-02	2024-03-02
Antenna - Standard Gain	ETS Lindgren	3160-07	AHU	NCR	NCR
Antenna - Standard Gain	ETS Lindgren	3160-08	AHV	NCR	NCR
Antenna - Standard Gain	ETS Lindgren	3160-09	AHY	NCR	NCR
Antenna - Standard Gain	ETS Lindgren	3160-10	AIW	NCR	NCR
Antenna - Standard Gain	OML, Inc.	M19RH	AZT	NCR	NCR
Antenna - Standard Gain	OML, Inc.	M12RH	AZU	NCR	NCR
Antenna - Standard Gain	OML, Inc	M80RH	AZV	NCR	NCR
Amplifier - Pre-Amplifier	Fairview Microwave	FMAM63001	PAY	2023-01-16	2024-01-16
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	PAG	2023-03-26	2024-03-26
Amplifier - Pre-Amplifier	L-3 Narda-MITEQ	AMF-6F-08001200-30-10P	PAO	2022-11-03	2023-11-03
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AVD	2022-11-03	2023-11-03
Amplifier - Pre-Amplifier	Miteq	JSW45-26004000-40-5P	PAE	2023-03-26	2024-03-26
Spectrum Analyzer Extension Module	Virginia Diodes, Inc.	WR19SAX	AFT	2021-04-01	2024-04-01
Spectrum Analyzer Extension Module	Virginia Diodes, Inc.	WR12SAX	AFU	2021-04-09	2024-04-09
Spectrum Analyzer Extension Module	Virginia Diodes, Inc.	WR8.0SAX	AFV	2021-05-05	2024-05-05
Cable	None	10m Test Distance Cable	EVL	2023-01-16	2024-01-16
Cable	N/A	Double Ridge Horn Cables	EVB	2023-03-26	2024-03-26
Cable	None	Standard Gain Horn Cables	EVF	2022-11-03	2023-11-03
Cable	Micro-Coax	UFD150A-1-0720-200200	EVH	2023-03-13	2024-03-13
Cable	ESM Cable Corp.	KNKN-72 SMA Cable	EVZ	2023-03-26	2024-03-26
Filter - Low Pass	Fairview Microwave	FMFL020	PLE	2023-02-13	2024-02-13
Power Supply - DC	Topward	TPS-2000	TPD	NCR	NCR

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	5.2 dB	-5.2 dB

FREQUENCY RANGE INVESTIGATED

30 MHz TO 100 GHz

POWER INVESTIGATED

24 VDC

CONFIGURATIONS INVESTIGATED

OPCO0004-2

MODES INVESTIGATED

FMCW: 24.04 - 24.24 GHz

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

EUT:	OVS-02 Series	Work Order:	OPCO0004
Serial Number:	50	Date:	2023-06-09
Customer:	OPTEX Co., Ltd.	Temperature:	21.3°C
Attendees:	Takuya Matsumoto and Toshiyasu Matsuyama	Relative Humidity:	50.3%
Customer Project:	None	Bar. Pressure (PMSL):	1016 mb
Tested By:	Jeff Alcoke	Job Site:	EV11
Power:	24 VDC	Configuration:	OPCO0004-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.249:2023	ANSI C63.10:2013

TEST PARAMETERS

Run #:	2	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)

COMMENTS

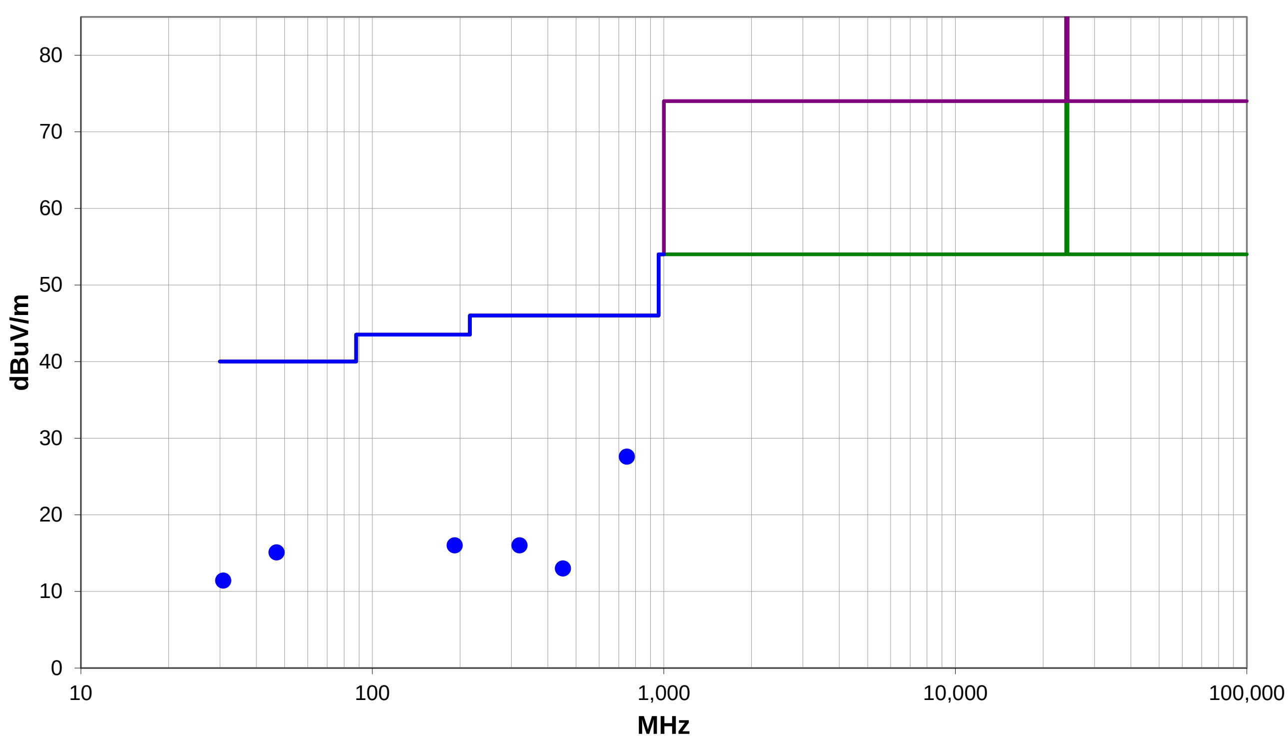
None

EUT OPERATING MODES

FMCW: 24.04 - 24.24 GHz

DEVIATIONS FROM TEST STANDARD

None



Run #: 2 PK AV QP

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #2

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	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)
746.349	37.4	-9.8	1.0	345.0	3.0	0.0	Vert	QP	0.0	27.6	46.0	-18.4
46.954	41.5	-26.4	3.98	228.0	3.0	0.0	Horz	QP	0.0	15.1	40.0	-24.9
191.754	40.6	-24.6	1.5	119.0	3.0	0.0	Horz	QP	0.0	16.0	43.5	-27.5
30.765	30.2	-18.8	1.0	157.0	3.0	0.0	Horz	QP	0.0	11.4	40.0	-28.6
319.660	36.2	-20.2	1.0	220.0	3.0	0.0	Horz	QP	0.0	16.0	46.0	-30.0
450.808	29.7	-16.7	1.0	29.0	3.0	0.0	Vert	QP	0.0	13.0	46.0	-33.0

CONCLUSION

Pass

Tested By

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

EUT:	OVS-02 Series	Work Order:	OPCO0004
Serial Number:	50	Date:	2023-06-07
Customer:	OPTEX Co., Ltd.	Temperature:	22.4°C
Attendees:	Takuya Matsumoto and Toshiyasu Matsuyama	Relative Humidity:	44.9%
Customer Project:	None	Bar. Pressure (PMSL):	1012 mb
Tested By:	Jeff Alcoke	Job Site:	EV01
Power:	24 VDC	Configuration:	OPCO0004-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.249:2023	ANSI C63.10:2013

TEST PARAMETERS

Run #:	7	Test Distance (m):	0.1	Ant. Height(s) (m):	1.0 – 2.0

COMMENTS

Please reference data comments below for EUT orientation and operating voltage.

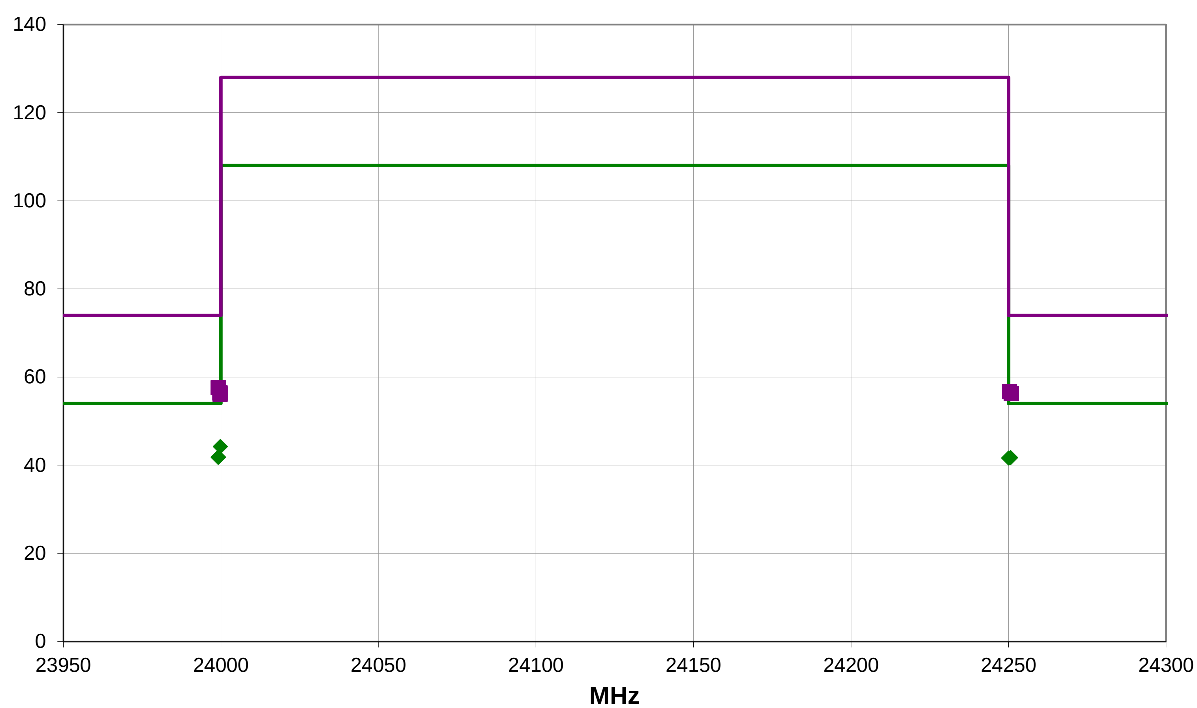
From the duty cycle data contained in this report, the smallest T_{Chirp} = 63 µS
BW_{Chirp} = 180 MHz
α = 0.62
FMCW factor = 10*log (0.62) = 2.1 dB

EUT OPERATING MODES

FMCW: 24.04 - 24.24 GHz

DEVIATIONS FROM TEST STANDARD

None



Run #: 7 PK AV QP

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #7

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	FMCW Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
23999.820	30.1	43.6	1.6	0.0	0.0	0.0	Horz	AV	-29.5	44.2	54.0	-9.8	EUT X-axis
23999.230	27.7	43.6	1.6	0.0	0.0	0.0	Vert	AV	-29.5	41.8	54.0	-12.2	EUT Y-axis
23999.110	27.7	43.6	1.6	0.0	0.0	0.0	Horz	AV	-29.5	41.8	54.0	-12.2	EUT X-axis, 12 VDC
24250.670	27.6	43.6	1.6	0.0	0.0	0.0	Vert	AV	-29.5	41.7	54.0	-12.3	EUT X-axis
24250.110	27.5	43.6	1.6	0.0	0.0	0.0	Horz	AV	-29.5	41.6	54.0	-12.4	EUT Y-axis
23999.090	41.4	43.6	1.6	0.0	2.1	0.0	Vert	PK	-29.5	57.6	74.0	-16.4	EUT Y-axis
24250.330	40.5	43.6	1.6	0.0	2.1	0.0	Vert	PK	-29.5	56.7	74.0	-17.3	EUT X-axis
23999.710	40.2	43.6	1.6	0.0	2.1	0.0	Horz	PK	-29.5	56.4	74.0	-17.6	EUT X-axis
24250.860	40.1	43.6	1.6	0.0	2.1	0.0	Horz	PK	-29.5	56.3	74.0	-17.7	EUT Y-axis
23999.740	39.9	43.6	1.6	0.0	2.1	0.0	Horz	PK	-29.5	56.1	74.0	-17.9	EUT X-axis, 12 VDC

CONCLUSION

Pass

Tested By

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

EUT:	OVS-02 Series	Work Order:	OPCO0004
Serial Number:	50	Date:	2023-06-08
Customer:	OPTEX Co., Ltd.	Temperature:	22.5°C
Attendees:	Takuya Matsumoto and Toshiyasu Matsuyama	Relative Humidity:	46.2%
Customer Project:	None	Bar. Pressure (PMSL):	1015 mb
Tested By:	Jeff Alcoke	Job Site:	EV01
Power:	24 VDC	Configuration:	OPCO0004-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.249:2023	ANSI C63.10:2013

TEST PARAMETERS

Run #:	12	Test Distance (m):	1	Ant. Height(s) (m):	1 - 2

COMMENTS

Please reference data comments below for EUT orientation and operating voltage.

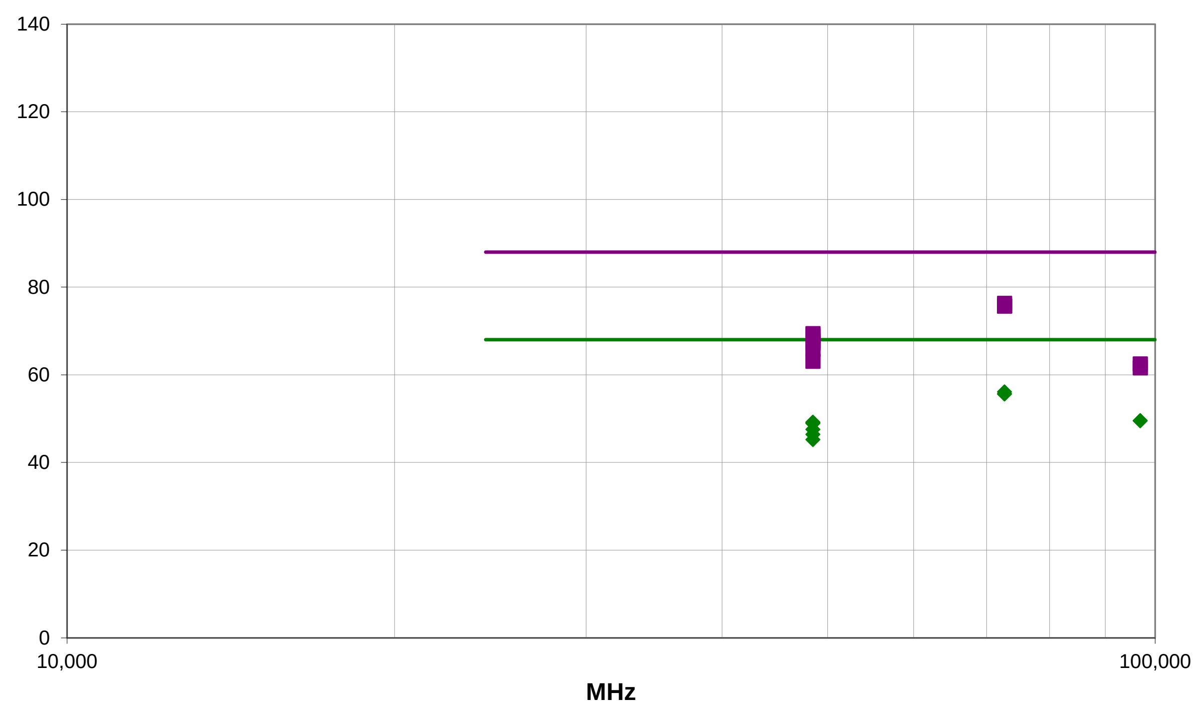
From the duty cycle data contained in this report, the smallest T_{Chirp} = 63 µS
BW_{Chirp} = 180 MHz
α = 0.62
FMCW factor = 10*log (0.62) = 2.1 dB

EUT OPERATING MODES

FMCW: 24.04 - 24.24 GHz

DEVIATIONS FROM TEST STANDARD

None



Run #: 12 ■ PK ◆ AV ● QP

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #12

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	FMCW Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
72729.590	42.5	43.3	1.7	0.0	2.1	0.0	Vert	PK	-9.5	76.3	88.0	-11.7	EUT X-axis
72729.600	22.3	43.3	1.7	0.0	0.0	0.0	Vert	AV	-9.5	56.1	68.0	-11.9	EUT X-axis
72730.160	41.9	43.3	1.7	0.0	2.1	0.0	Horz	PK	-9.5	75.7	88.0	-12.3	EUT Y-axis
72730.350	41.9	43.3	1.7	0.0	2.1	0.0	Vert	PK	-9.5	75.7	88.0	-12.3	EUT X-axis, 12 VDC
72730.760	21.8	43.3	1.7	0.0	0.0	0.0	Horz	AV	-9.5	55.6	68.0	-12.4	EUT Y-axis
72730.330	21.8	43.3	1.7	0.0	0.0	0.0	Vert	AV	-9.5	55.6	68.0	-12.4	EUT X-axis, 12 VDC
96923.460	13.2	45.8	1.7	0.0	0.0	0.0	Horz	AV	-9.5	49.5	68.0	-18.5	EUT Y-axis
96924.550	13.2	45.8	1.7	0.0	0.0	0.0	Vert	AV	-9.5	49.5	68.0	-18.5	EUT X-axis
48484.110	39.1	39.8	1.6	360.0	2.1	0.0	Horz	PK	-9.5	69.4	88.0	-18.6	EUT Y-axis
48480.490	18.9	39.8	1.7	37.0	0.0	0.0	Horz	AV	-9.5	49.2	68.0	-18.8	EUT X-axis
48484.270	18.8	39.8	1.6	360.0	0.0	0.0	Horz	AV	-9.5	49.1	68.0	-18.9	EUT Y-axis
48481.080	38.6	39.8	1.6	360.0	2.1	0.0	Vert	PK	-9.5	68.9	88.0	-19.1	EUT X-axis
48481.430	18.6	39.8	1.6	360.0	0.0	0.0	Vert	AV	-9.5	48.9	68.0	-19.1	EUT X-axis
48477.000	37.5	39.8	1.7	37.0	2.1	0.0	Horz	PK	-9.5	67.8	88.0	-20.2	EUT X-axis
48483.350	17.2	39.8	1.7	315.0	0.0	0.0	Vert	AV	-9.5	47.5	68.0	-20.5	EUT Y-axis
48483.440	36.9	39.8	1.7	315.0	2.1	0.0	Vert	PK	-9.5	67.2	88.0	-20.8	EUT Y-axis
48484.930	16.1	39.8	1.6	45.0	0.0	0.0	Vert	AV	-9.5	46.4	68.0	-21.6	EUT Z-axis
48484.800	35.5	39.8	1.6	45.0	2.1	0.0	Vert	PK	-9.5	65.8	88.0	-22.2	EUT Z-axis
48484.770	14.9	39.8	1.7	203.0	0.0	0.0	Horz	AV	-9.5	45.2	68.0	-22.8	EUT Z-axis
48484.530	32.8	39.8	1.7	203.0	2.1	0.0	Horz	PK	-9.5	63.1	88.0	-24.9	EUT Z-axis
96923.040	26.2	45.8	1.7	0.0	2.1	0.0	Vert	PK	-9.5	62.5	88.0	-25.5	EUT X-axis
96925.290	25.3	45.8	1.7	0.0	2.1	0.0	Horz	PK	-9.5	61.6	88.0	-26.4	EUT Y-axis

CONCLUSION

Pass

Tested By

FIELD STRENGTH OF FUNDAMENTAL

WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

TEST DESCRIPTION

The antennas to be used with the EUT were tested. The EUT was configured to transmit an FMCW signal at maximum power. While scanning, emissions from the EUT were maximized by rotating the EUT, adjusting the measurement antenna height and polarization, and manipulating the EUT and EUT antenna in 3 orthogonal planes.

Average measurements were collected using the following settings:

- Start Frequency = Lower than the lower edge of the operating frequency range
- Stop Frequency = Higher than the upper edge of the operating frequency range
- RBW = 1 MHz
- VBW = VBW ≥ 3*RBW
- Detector = RMS
- Averaging mode = Power (RMS) averaging
- Sweep = Continuous (Free Run)
- Sweep time = N *EUT cycle time * Number of Points, where N ≥ 5

PK measurements were collected using the following settings:

- Start Frequency = Lower than the lower edge of the operating frequency range
- Stop Frequency = Higher than the upper edge of the operating frequency range
- RBW = 1 MHz
- VBW = VBW ≥ 3*RBW
- Detector = Peak
- Display mode = Max Hold
- Sweep = Continuous (Free Run)
- Sweep time ≥ EUT cycle time * Number of Point

The PK measurements were further corrected with an FMCW Factor as called out in ANSI C63.10:2020, Annex L, using the following equation:

$$\alpha = \frac{1}{\sqrt{1+\left(\frac{2\ln(2)}{\pi}\right)^2\left(\frac{BW_{\text{Chirp}}}{T_{\text{Chirp}}B^2}\right)^2}}$$

where

α	is the reduction in amplitude
BW_{Chirp}	is the FMCW Chirp Bandwidth
T_{Chirp}	is the FMCW Chirp Time
B	is the 3 dB IF Bandwidth = RBW

FMCW Factor (dB) = 10*log(α)

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFI	2022-12-19	2023-12-19
Cable	Micro-Coax	UFD150A-1-0720-200200	EVH	2023-03-13	2024-03-13
Antenna - Standard Gain	ETS Lindgren	3160-09	AHY	NCR	NCR
Power Supply - DC	Topward	TPS-2000	TPD	NCR	NCR

MEASUREMENT UNCERTAINTY

Description		
Expanded k=2	5.2 dB	-5.2 dB

FIELD STRENGTH OF FUNDAMENTAL

WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

FREQUENCY RANGE INVESTIGATED

24 GHz TO 24.25 GHz

POWER INVESTIGATED

24 VDC, 12 VDC

CONFIGURATIONS INVESTIGATED

OPCO0004-2

MODES INVESTIGATED

FMCW: 24.04 - 24.24 GHz

FIELD STRENGTH OF FUNDAMENTAL

EUT:	OVS-02 Series	Work Order:	OPCO0004
Serial Number:	50	Date:	2023-06-07
Customer:	OPTEX Co., Ltd.	Temperature:	22.9°C
Attendees:	Takuya Matsumoto and Toshiyasu Matsuyama	Relative Humidity:	44.4%
Customer Project:	None	Bar. Pressure (PMSL):	1011 mb
Tested By:	Jeff Alcoke	Job Site:	EV01
Power:	24 VDC	Configuration:	OPCO0004-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 15.249:2023	ANSI C63.10:2013

TEST PARAMETERS

Run #:	9	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)

COMMENTS

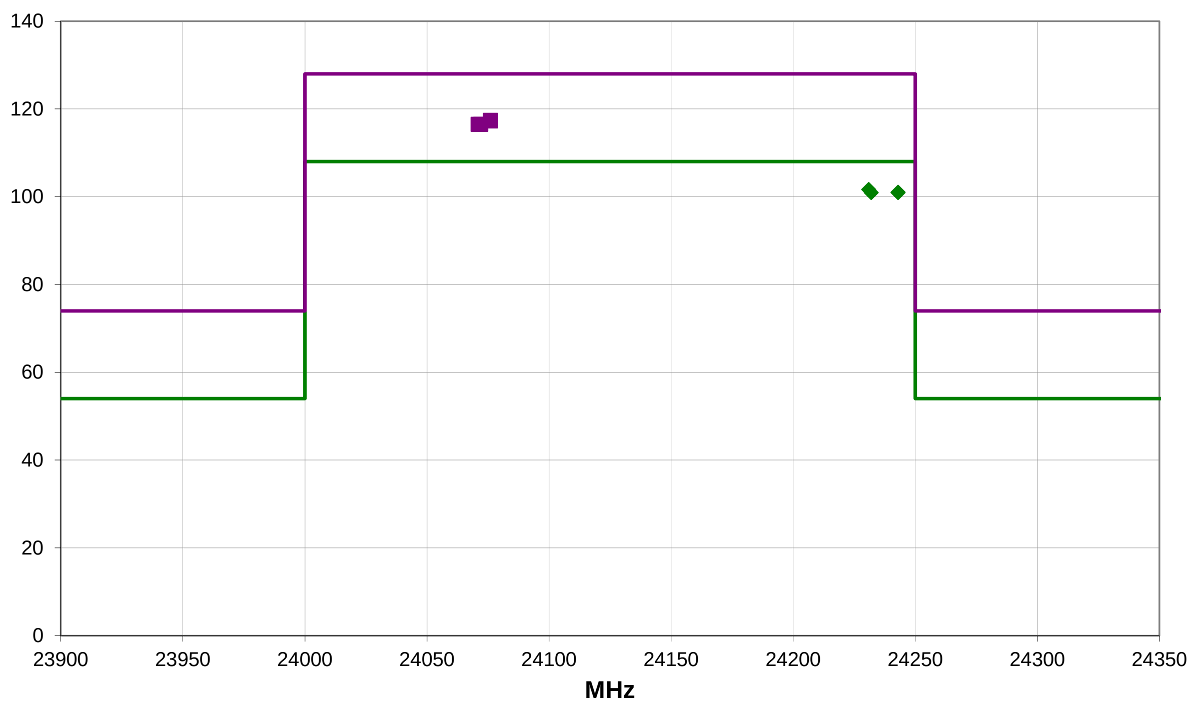
Testing performed using worst case orientation as determined from pre-compliance testing.
From the duty cycle data contained in this report, the smallest T_{Chirp} = 63 µS
BW_{Chirp} = 180 MHz
α = 0.62
FMCW factor = 10*log (0.62) = 2.1 dB
Please reference data comments below for EUT orientation and operating voltage.

EUT OPERATING MODES

FMCW: 24.04 - 24.24 GHz

DEVIATIONS FROM TEST STANDARD

None



Run #: 9 PK AV QP

FIELD STRENGTH OF FUNDAMENTAL

element
WTD.2023.04.25.0
EmiR5 2022.07.06.0
PSA-ESCI 2023.04.25.0

RESULTS - Run #9

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	FMCW factor (dB)	External Attenuation (dB)	Polarity/ Transducer	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
24231.000	58.0	43.6	1.8	7.0	0.0	0.0	Horz	AV	0.0	101.6	108.0	-4.3	EUT Y-axis, 24 VDC
24243.000	57.4	43.6	1.7	0.0	0.0	0.0	Vert	AV	0.0	101.0	108.0	-4.9	EUT X-axis, 24 VDC
24243.000	57.3	43.6	1.7	0.0	0.0	0.0	Vert	AV	0.0	100.9	108.0	-5.0	EUT X-axis, 12 VDC
24232.000	57.3	43.6	1.8	7.0	0.0	0.0	Horz	AV	0.0	100.9	108.0	-5.0	EUT Y-axis, 12 VDC
24076.000	71.7	43.6	1.8	7.0	2.1	0.0	Horz	PK	0.0	117.4	128.0	-12.7	EUT Y-axis, 12 VDC
24076.000	71.6	43.6	1.8	7.0	2.1	0.0	Horz	PK	0.0	117.3	128.0	-12.8	EUT Y-axis, 24 VDC
24072.000	70.8	43.6	1.7	0.0	2.1	0.0	Vert	PK	0.0	116.5	128.0	-13.6	EUT X-axis, 12 VDC
24071.000	70.8	43.6	1.7	0.0	2.1	0.0	Vert	PK	0.0	116.5	128.0	-13.6	EUT X-axis, 24 VDC

CONCLUSION

Pass

Tested By

OCCUPIED BANDWIDTH

XMit 2023.02.14.0

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
Antenna - Standard Gain	ETS Lindgren	3160-09	AHY	NCR	NCR
Cable	Micro-Coax	UFD150A-1-0720-200200	EVH	2023-03-13	2024-03-13
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	2022-09-08	2023-09-08

TEST DESCRIPTION

The measurement was made in a radiated configuration of the fundamental with the carrier fully maximized for its highest radiated power.

The 20 dB occupied bandwidth was measured with the EUT configured for continuous modulated operation.

Per ANSI C63.10:2013, 6.9.2, the spectrum analyzer was configured as follows:

- SPAN = 2 – 5 times OBW
- RBW = 1 – 5% of the OBW
- VBW ≥ 3 * RBW
- Detector = PK
- Sweep = Auto
- Trace = Max Hold

The spectrum analyzer occupied bandwidth measurement function was used to sum the power of the transmission in linear terms to obtain the 20 dB bandwidth. The 99% Occupied Bandwidth was also measured and reported.

OCCUPIED BANDWIDTH

element

XMit 2023.02.14.0

EUT:	OVS-02 Series			Work Order:	OPCO0004
Serial Number:	50			Date:	06/08/23
Customer:	OPTEX Co., Ltd.			Temperature:	20.3°C
Attendees:	Takuya Matsumoto and Toshiyasu Matsuyama			Humidity:	60.2%
Project:	None			Barometric Pres.:	1017 mbar
Tested by:	Jeff Alcoke	Power:	24 VDC	Job Site:	EV01

TEST SPECIFICATIONS	Test Method
FCC 15.249:2023	ANSI C63.10:2013

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

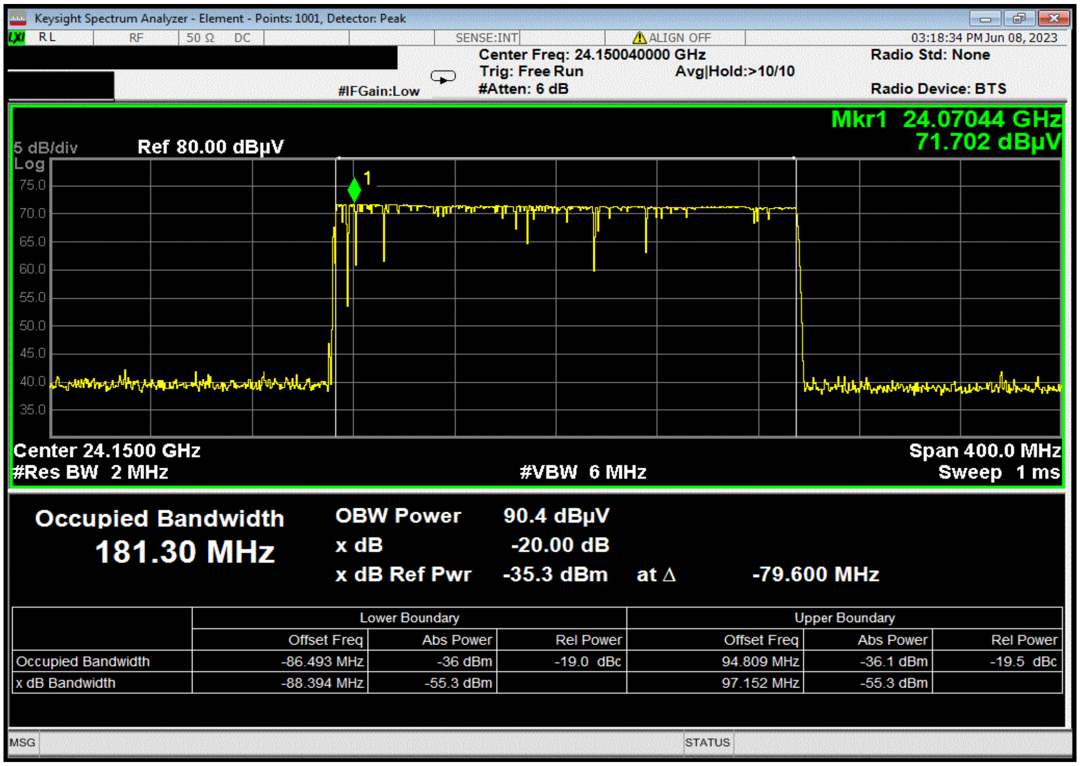
Configuration #	OPCO0004-2	Signature

	20 dB BW (MHz)	99% BW (MHz)	*xdB f*_low (GHz)	*xdB f*_high (GHz)	Limit (GHz)	Result
FMCW: 24.04 - 24.24 GHz	182.546	181.3	24.1	24.247	24.0 ≤ f ≤ 24.25	Pass

OCCUPIED BANDWIDTH

XMit 2023.02.14.0

FMCW: 24.04 - 24.24 GHz							
		20 dB BW (MHz)	99% BW (MHz)	xdB f_low (GHz)	xdB f_high (GHz)	Limit (GHz)	Result
		182.5	181.3	24.1	24.25	24.0 ≤ *f* ≤ 24.25	Pass



DUTY CYCLE

XMit 2023.02.14.0

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
Antenna - Standard Gain	ETS Lindgren	3160-09	AHY	NCR	NCR
Cable	Micro-Coax	UFD150A-1-0720-200200	EVH	2023-03-13	2024-03-13
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	2022-09-08	2023-09-08

TEST DESCRIPTION

The measurement was made in a radiated configuration of the fundamental with the carrier fully maximized for its highest radiated power.

The Duty Cycle (x) of the single channel operation of the radio as controlled by the provided test software was measured for each of the EUT operating modes.

There is no compliance requirement to be met by this test, so therefore no Pass / Fail criteria.

The measurements were made using a zero span on the spectrum analyzer to see the pulses in the time domain. The transmit power was set to its default maximum.

The duty cycle was calculated by dividing the transmission pulse duration (T) by the total period of a single on and total off time.

If the transmit duty cycle < 98 percent, burst gating may have been used during some of the other tests in this report to only take the measurement during the burst duration.

DUTY CYCLE

XMit 2023.02.14.0

EUT:	OVS-02 Series	Work Order:	OPCO0004
Serial Number:	50	Date:	06/08/23
Customer:	OPTEX Co., Ltd.	Temperature:	20.5°C
Attendees:	Takuya Matsumoto and Toshiyasu Matsuyama	Humidity:	53.1%
Project:	None	Barometric Pres.:	1017 mbar
Tested by:	Jeff Alcoke — Power: 24 VDC	Job Site:	EV01

TEST SPECIFICATIONS	Test Method
FCC 15.249:2023	ANSI C63.10:2013

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

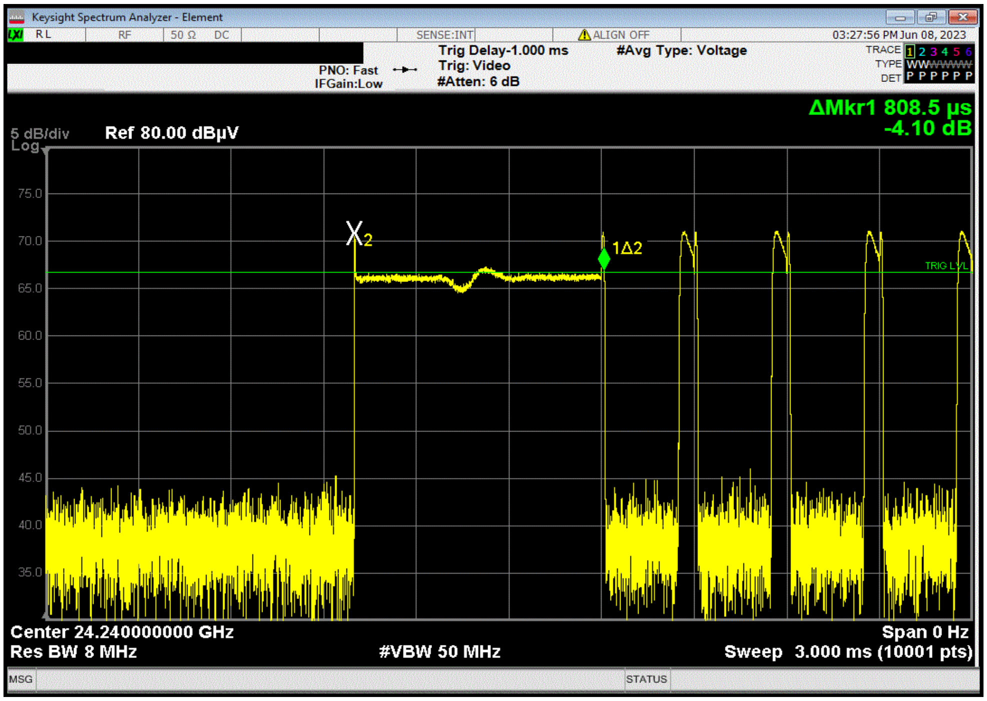
None

Configuration #	OPCO0004-2	*Signature*

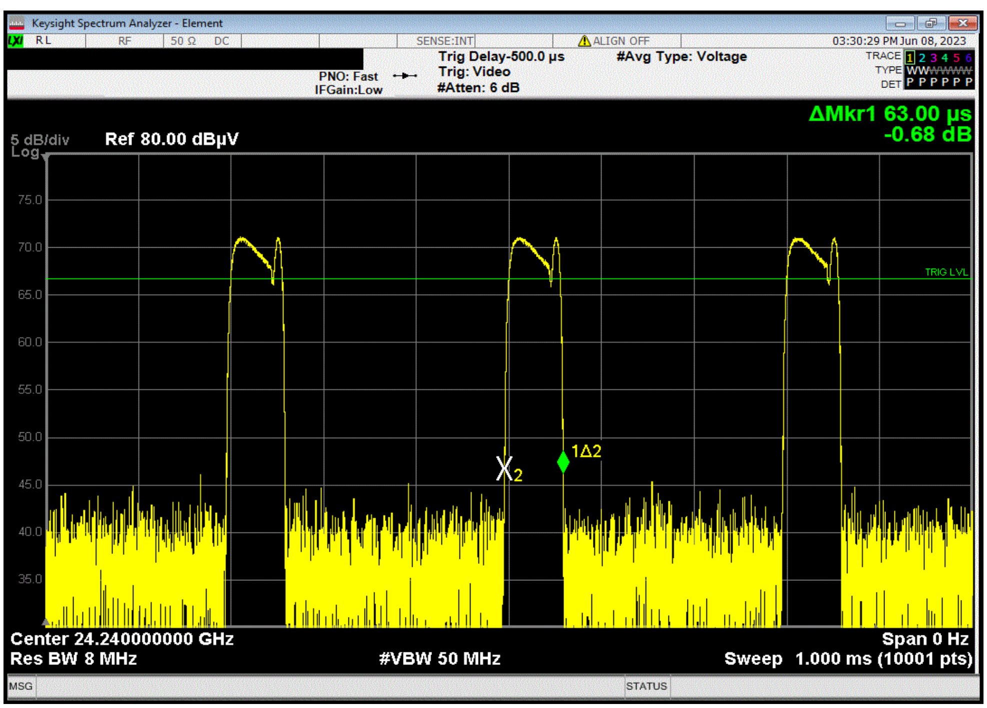
		Pulse Width (mS)	Number Pulse 1	Number Pulse 2	Period (mS)	Total On Time (mS)	Duty Cyle (%)	Limit	Result
FMCW: 24.04 - 24.24 GHz									
	Pulse Type 1	0.809	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Top	Pulse Type 2	0.063	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ttom1 Top	Burst Pattern	N/A	3	66	N/A	N/A	N/A	N/A	N/A
Top1 Bottom1 Top	Calculation	N/A	3	66	50	6.585	13.17	N/A	N/A

DUTY CYCLE

FMCW: 24.04 - 24.24 GHz, Pulse Type 1							
Pulse Width (mS)	Number Pulse 1	Number Pulse 2	Period (mS)	Total On Time (mS)	Duty Cyle (%)	Limit	Result
0.809	N/A	N/A	N/A	N/A	N/A	N/A	N/A



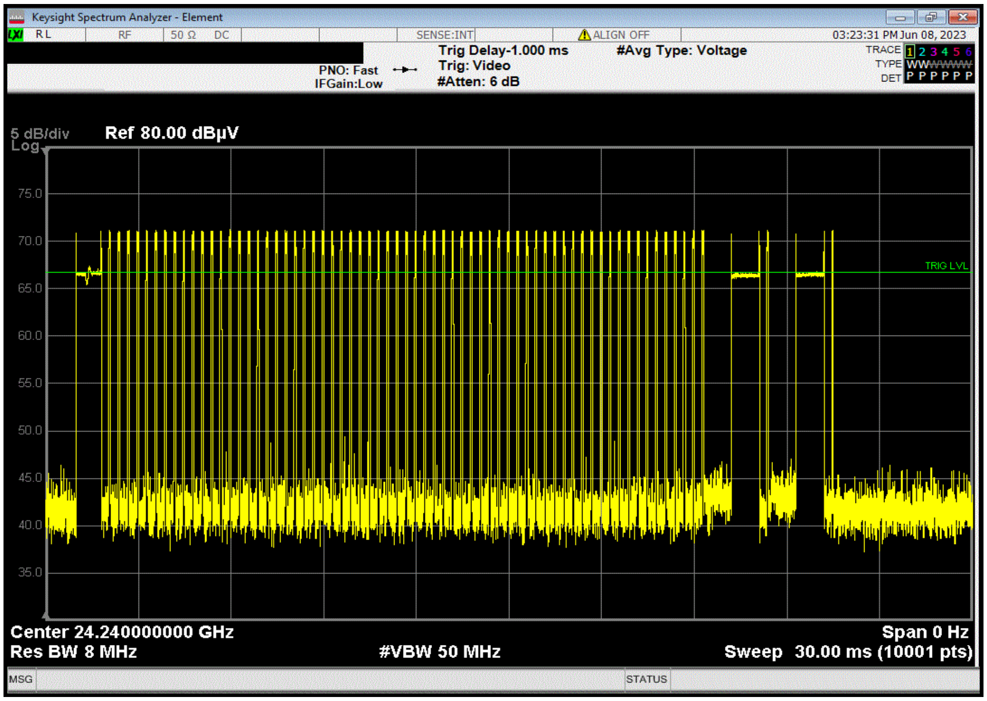
FMCW: 24.04 - 24.24 GHz, Pulse Type 2							
Pulse Width (mS)	Number Pulse 1	Number Pulse 2	Period (mS)	Total On Time (mS)	Duty Cyle (%)	Limit	Result
0.063	N/A	N/A	N/A	N/A	N/A	N/A	N/A



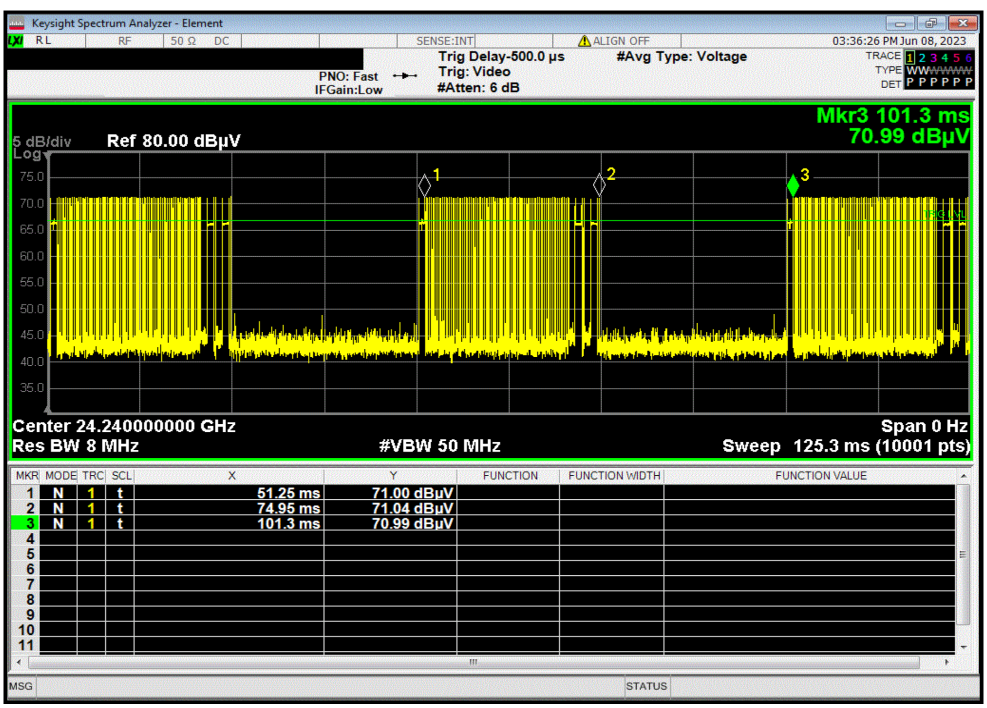
DUTY CYCLE

XMit 2023.02.14.0

FMCW: 24.04 - 24.24 GHz, Burst Pattern							
Pulse Width (mS)	Number Pulse 1	Number Pulse 2	Period (mS)	Total On Time (mS)	Duty Cyle (%)	Limit	Result
N/A	3	66	N/A	N/A	N/A	N/A	N/A



FMCW: 24.04 - 24.24 GHz, Calculation							
Pulse Width (mS)	Number Pulse 1	Number Pulse 2	Period (mS)	Total On Time (mS)	Duty Cyle (%)	Limit	Result
N/A	3	66	50	6.585	13.17	N/A	N/A



End of Test Report