



Banner Engineering Corp.

MR24 Radar FDS Sensor

FCC 15.249:2025

24.0-24.25 GHz General Usage

Report: BANN0742.0 Rev. 01, Issue Date: January 15, 2026



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CERTIFICATE OF TEST



Last Date of Test: November 21, 2025

Banner Engineering Corp.

EUT: MR24 Radar FDS Sensor

Radio Equipment Testing

Standards

Specification	Method
FCC 15.249:2025	ANSI C63.10:2020 + COR.1:2023

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)	6.4, 6.5, 6.6, 9.10	
Field Strength of Harmonics and Spurious Radiated Emissions - Above 40 GHz	Pass	15.249(a),(c-e)	6.4, 6.5, 6.6, 9.10	
Antenna Beamwidth	N/A	15.249(b)(3)	6.6	Not required unless the EUT is intended for fixed point-to-point operation
Radiated Band Edge Emissions	Pass	15.249(d)	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
Emission Bandwidth	Pass	15.215(c)	6.9.2	
Duty Cycle	Pass	N/A	7.5	

Deviations From Test Standards

None

Approved By:

Kyle Fujimoto, EMC Test Engineer
Signed for and on behalf of Element

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 calibration date of test equipment ID: AVO	2026-01-13	23
	Added table for far-field measurement distance calculations		33, 38
	Added equation for distance correction and the distance correction factor used for testing		28, 33, 38

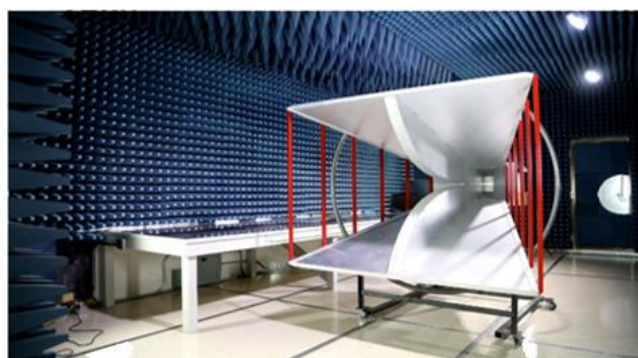
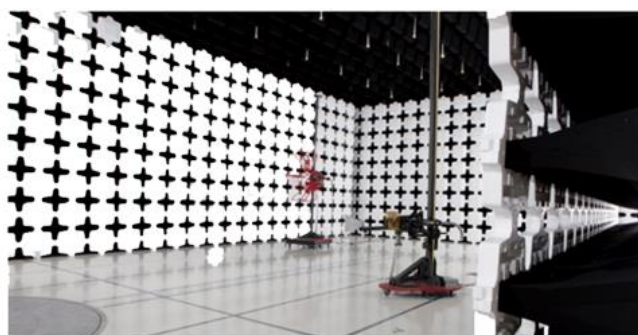
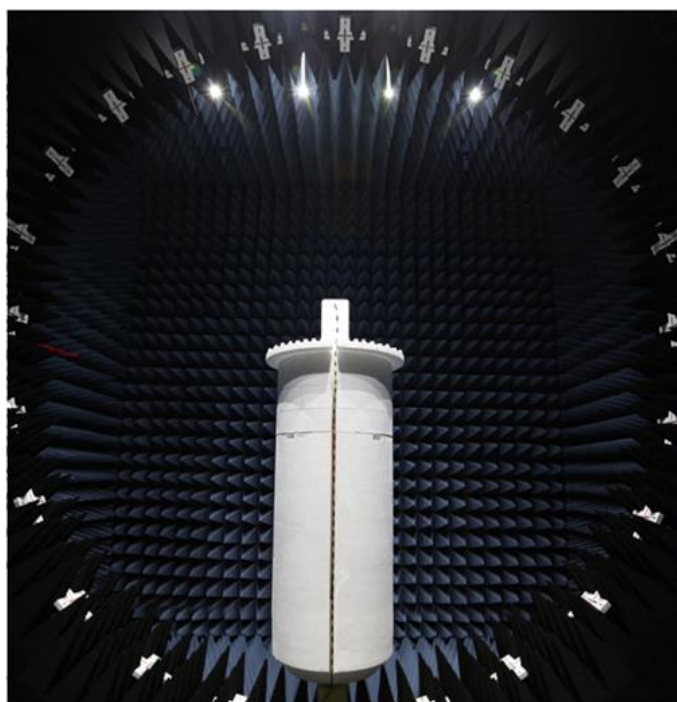
FACILITIES

Testing was performed at the following location(s)

	Location	Labs ⁽¹⁾	Address	A2LA ⁽²⁾	ISED ⁽³⁾	BSMI ⁽⁴⁾	VCCI ⁽⁵⁾	CAB	FDA ⁽⁶⁾
☐	California	OC01-17	41 Tesla Irvine, CA 92618 (949) 861-8918	3310.04	2834B	SL2-IN-E-1154R	A-0029	US0158	TL-55
☒	Minnesota	MN01-11	9349 W Broadway Ave. Brooklyn Park, MN 55445 (612) 638-5136	3310.05	2834E	SL2-IN-E-1152R	A-0109	US0175	TL-57
☒	Oregon	EV01-12	6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	3310.02	2834D	SL2-IN-E-1017	A-0108	US0017	TL-56
☐	Washington	NC01-05	19201 120th Ave NE Bothell, WA 98011 (425) 984-6600	3310.06	2834F	SL2-IN-E-1153R	A-0110	US0157	TL-67
☐	Offsite	N/A	See Product Description	N/A	N/A	N/A	N/A	N/A	N/A

See data sheets for specific labs

- (1) The lab designations denote individual rooms within each location. (OC01, OC02, OC03, etc.)
- (2) A2LA Certificate No.
- (3) ISED Company No.
- (4) BSMI No.
- (5) VCCI Site Filing No.
- (6) FDA ASCA No.



MEASUREMENT UNCERTAINTY

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 reported is based on statistical analysis that was performed by the laboratory. 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.

Various Measurements

Test	All Labs (+/-)
Frequency Accuracy (%)	0.0007
Amplitude Accuracy (dB)	1.2
Conducted Power (dB)	1.2
Radiated Power via Substitution (dB)	0.7
Temperature (degrees C)	0.7
Humidity (% RH)	2.5
Voltage (AC) (%)	1
Voltage (DC) (%)	0.7
Near-field Measurement of E-Field (dB)	1.89
Near-field Measurement of H-Field (dB)	2.65

Field Strength Measurements (dB)

Range	MN05 (+/-)	EV01 (+/-)
10kHz-30MHz	1.8	1.8
30MHz-1GHz 3m	4.6	4.6
1GHz-6GHz	5.1	5.1
6GHz-40GHz	5.3	5.2

TEST SETUP BLOCK DIAGRAMS

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.

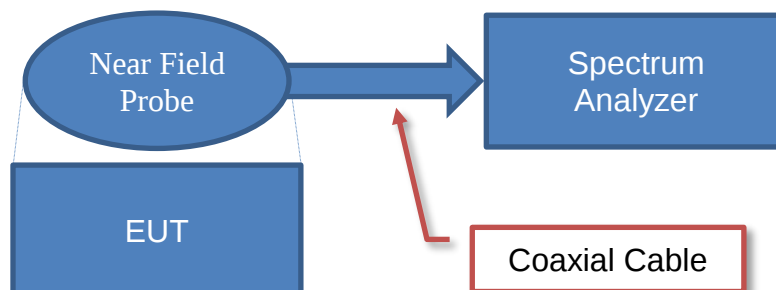
Antenna Port Conducted Measurements



Sample Calculation (logarithmic units)

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

Near Field Test Fixture Measurements

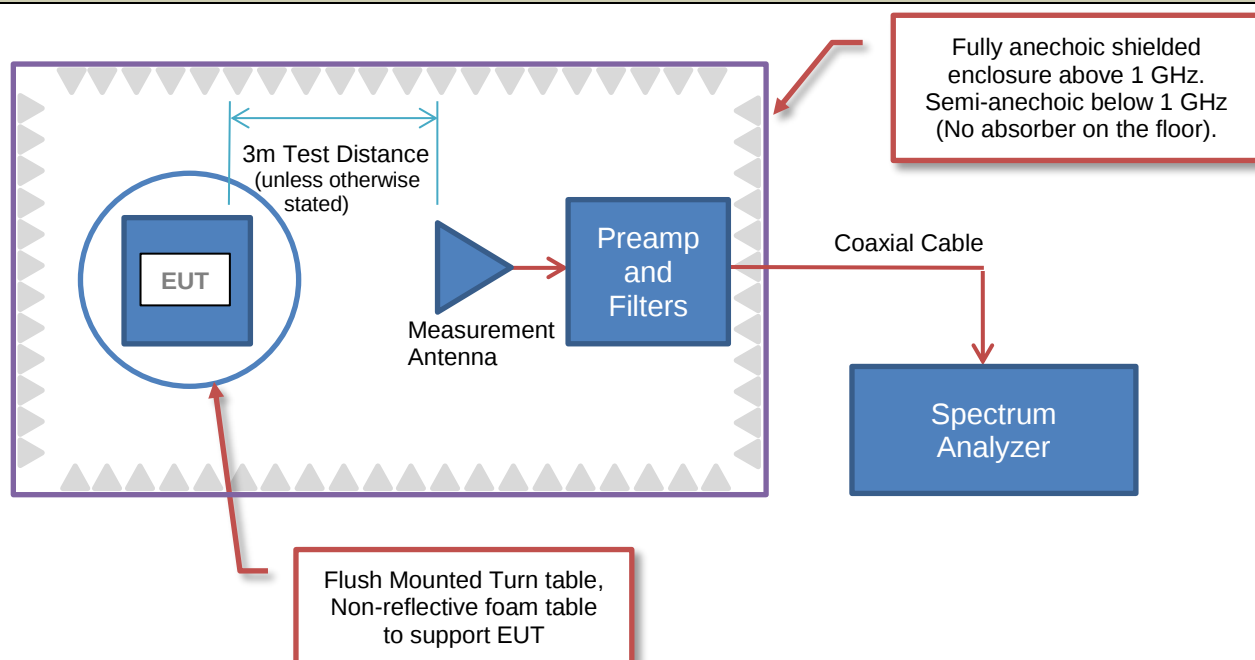


Sample Calculation (logarithmic units)

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			Distance Adjustment Factor	External Attenuation	Field Strength
	Antenna Factor	Cable Factor	Amplifier Gain			
42.6	28.6	3.1	40.8	0.0	0.0	33.5

Conducted Emissions:

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

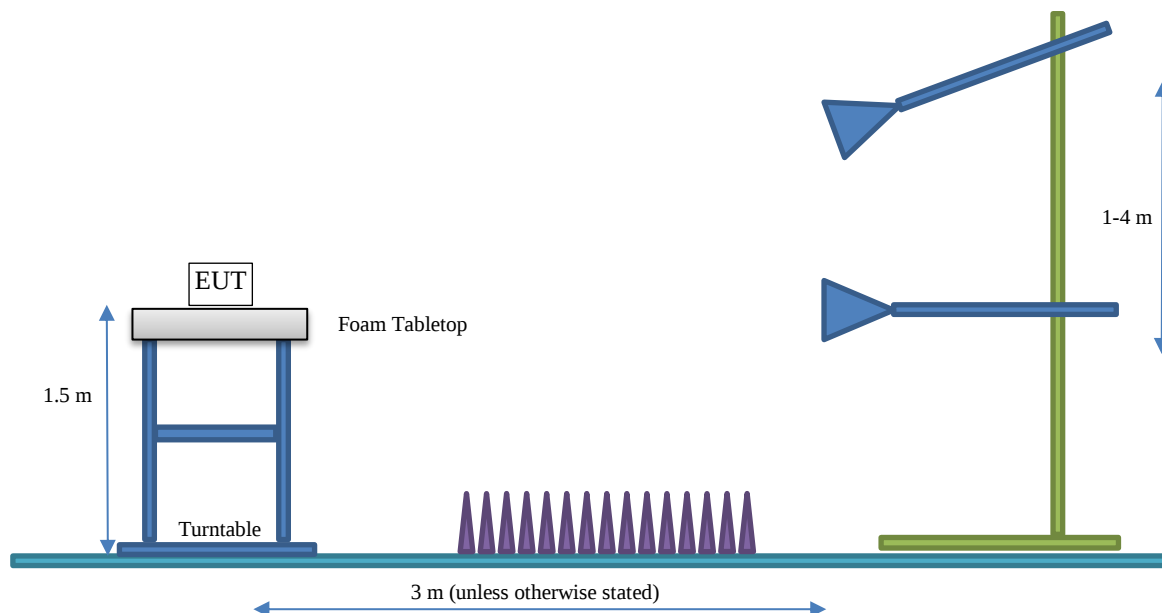
Radiated Power (ERP/EIRP) – Substitution Method:

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:	Banner Engineering Corp.
Address:	9714 - 10th Avenue North
City, State, Zip:	Minneapolis, MN 55441-5093
Test Requested By:	Joel Jankord
EUT:	MR24 Radar FDS Sensor
First Date of Test:	September 16, 2025
Last Date of Test:	November 21, 2025
Receipt Date of Samples:	September 16, 2025
Equipment Design Stage:	Prototype
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:

The MR24 is an integrated single-chip mmWave sensor SoC based on FMCW radar transceiver technology. It works in the 24 GHz K-band with up to 1 GHz modulation bandwidth in every single frequency sweeping chirp.

Testing Objective:

Seeking to demonstrate compliance under FCC 15.249:2025 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)
PCB Microstrip Patch	Banner Engineering Corp.	24.0 – 24.25 GHz	6

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

- ☒ Test software settings Software / firmware used for testing: 1.0
☐ Rated power settings

SETTINGS FOR ALL TESTS IN THIS REPORT

Modulation Types	Frequency Band(GHz)	Power Setting (dBm)
FMCW - Sawtooth	24.01 – 24.24	12 ± 0.5

MODULATION PARAMETERS:

Parameter	Value
Sweep Bandwidth (MHz)	230 MHz
Sweep Rate (Hz/nsec)	523 Hz/ns
Sweep Time (µsec)	440 us
Cycle Time (µsec)	667 us

CONFIGURATIONS



Configuration BANN0742-1

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
MR24 Radar FDS Sensor	Banner Engineering Corp.	None	RD2507007

Peripherals in Test Setup Boundary			
Description	Manufacturer	Model/Part Number	Serial Number
Class 2 Power Supply	Banner Engineering Corp.	PSW-24-1	N/A

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
IO Power Cable	No	1.8m	No	MR24 Radar FDS Sensor	Class 2 Power Supply

Software	
Description	Serial Number
(Banner Engineering Corp.) Iclegend 24GHz eval	1.0

Configuration BANN0742-2

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
MR24 Radar FDS Sensor	Banner Engineering Corp.	None	RD2507007

Peripherals in Test Setup Boundary			
Description	Manufacturer	Model/Part Number	Serial Number
Laptop	HP	ZBook Firefly 17 G7	5CG10617D2
Class 2 Power Supply	MR24 Radar FDS Sensor	PSW-24-1	N/A

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
Splitter	No	0.3	No	MR24 Radar FDS Sensor	DC Power / USB to COM
USB to COM	No	1.9	No	Splitter	Laptop
DC Power	No	2.2	No	Splitter	Class 2 Power Supply

Software	
Description	Serial Number
(Banner Engineering Corp.) Iclegend 24GHz eval	1.0
Banner Sensors GUI	3.7.1484 BETA

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2025-09-16	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.
2	2025-09-16	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.	EUT remained at Element following the test.
3	2025-10-12	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.
4	2025-11-13	Radiated Band Edge 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	2025-11-17	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.
6	2025-11-20	Emission 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.
7	2025-11-21	Field Strength of Harmonics and Spurious Radiated Emissions - Above 40 GHz	Tested as delivered to test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

POWERLINE CONDUCTED EMISSIONS

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
LISN	Solar Electronics	9252-50-R-24-BNC	LIY	2025-03-30	2026-03-30
Cable - Conducted Cable Assembly	Northwest EMC	MNC, HGN, TYK, VAE	MNCA	2025-02-14	2026-02-14
Receiver	Gauss Instruments	TDEMI 30M	ARS	2025-05-20	2026-05-20

CONFIGURATIONS INVESTIGATED

BANN0742-1

MODES INVESTIGATED

24 GHz Transmitting, CW Mid Ch 24.12 GHz
24 GHz Transmitting Sweeping FMCW

POWERLINE CONDUCTED EMISSIONS



EUT:	MR24 Radar FDS Sensor	Work Order:	BANN0742
Serial Number:	RD2507007	Date:	2025-09-16
Customer:	Banner Engineering Corp.	Temperature:	22.6°C
Attendees:	Kevin Kruse	Relative Humidity:	57.4%
Customer Project:	None	Bar. Pressure (PMSL):	1018 mb
Tested By:	Arnauld Dedry	Job Site:	MN05
Power:	110VAC/60Hz	Configuration:	BANN0742-1

TEST PARAMETERS

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

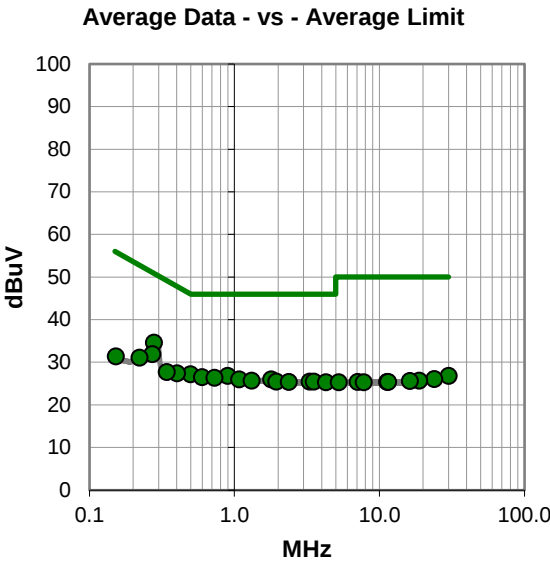
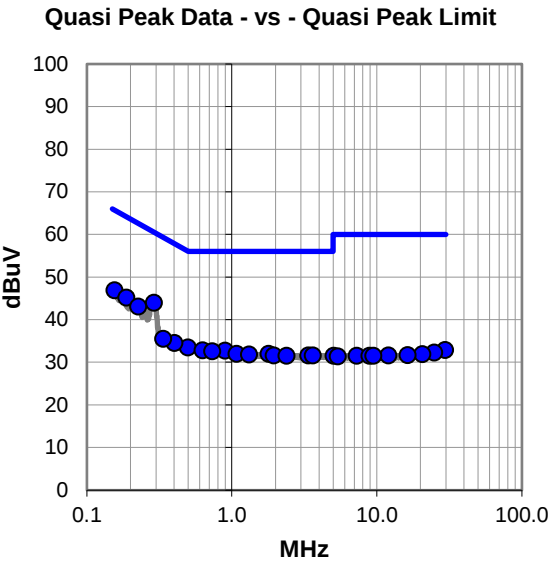
None

EUT OPERATING MODES

24 GHz Transmitting Sweeping FMCW

DEVIATIONS FROM TEST STANDARD

None



POWERLINE CONDUCTED EMISSIONS

RESULTS - Run #2

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.290	23.4	20.6	44.0	60.5	-16.5
0.155	25.8	21.1	46.9	65.8	-18.9
0.187	24.3	20.9	45.2	64.2	-19.0
0.226	22.3	20.8	43.1	62.6	-19.5
0.496	12.8	20.7	33.5	56.1	-22.6
0.629	12.0	20.8	32.8	56.0	-23.2
0.896	12.0	20.7	32.7	56.0	-23.3
0.402	13.9	20.6	34.5	57.8	-23.3
0.733	11.8	20.8	32.6	56.0	-23.4
0.336	14.9	20.6	35.5	59.3	-23.8
1.076	11.3	20.7	32.0	56.0	-24.0
1.795	11.3	20.7	32.0	56.0	-24.0
1.313	11.1	20.7	31.8	56.0	-24.2
1.943	10.9	20.7	31.6	56.0	-24.4
3.366	10.7	20.9	31.6	56.0	-24.4
3.617	10.7	20.9	31.6	56.0	-24.4
2.385	10.8	20.7	31.5	56.0	-24.5
29.606	10.0	22.9	32.9	60.0	-27.1
24.888	10.0	22.3	32.3	60.0	-27.7
20.548	10.0	21.9	31.9	60.0	-28.1
16.334	10.0	21.7	31.7	60.0	-28.3
12.006	10.2	21.4	31.6	60.0	-28.4
5.040	10.6	20.9	31.5	60.0	-28.5
7.242	10.5	21.0	31.5	60.0	-28.5
8.873	10.4	21.1	31.5	60.0	-28.5

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.278	14.0	20.6	34.6	50.9	-16.3
0.498	6.5	20.7	27.2	46.0	-18.8
0.271	11.2	20.7	31.9	51.1	-19.2
0.898	6.1	20.7	26.8	46.0	-19.2
0.597	5.8	20.7	26.5	46.0	-19.5
0.727	5.6	20.8	26.4	46.0	-19.6
1.078	5.3	20.7	26.0	46.0	-20.0
1.795	5.3	20.7	26.0	46.0	-20.0
1.311	5.0	20.7	25.7	46.0	-20.3
0.402	6.8	20.6	27.4	47.8	-20.4
1.946	4.8	20.7	25.5	46.0	-20.5
3.305	4.6	20.9	25.5	46.0	-20.5
3.514	4.6	20.9	25.5	46.0	-20.5
2.367	4.7	20.7	25.4	46.0	-20.6
4.273	4.4	20.9	25.3	46.0	-20.7
0.341	7.1	20.6	27.7	49.2	-21.5
0.222	10.3	20.8	31.1	52.8	-21.7
29.992	3.9	22.9	26.8	50.0	-23.2
23.913	3.8	22.3	26.1	50.0	-23.9
18.769	3.9	21.8	25.7	50.0	-24.3
16.232	3.9	21.7	25.6	50.0	-24.4
0.152	10.3	21.1	31.4	55.9	-24.5
7.082	4.4	21.0	25.4	50.0	-24.6
11.311	4.1	21.3	25.4	50.0	-24.6
11.444	4.1	21.3	25.4	50.0	-24.6

CONCLUSION

Pass



Tested By

POWERLINE CONDUCTED EMISSIONS



EUT:	MR24 Radar FDS Sensor	Work Order:	BANN0742
Serial Number:	RD2507007	Date:	2025-09-16
Customer:	Banner Engineering Corp.	Temperature:	22.6°C
Attendees:	Kevin Kruse	Relative Humidity:	57.4%
Customer Project:	None	Bar. Pressure (PMSL):	1018 mb
Tested By:	Arnauld Dedry	Job Site:	MN05
Power:	110VAC/60Hz	Configuration:	BANN0742-1

TEST PARAMETERS

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

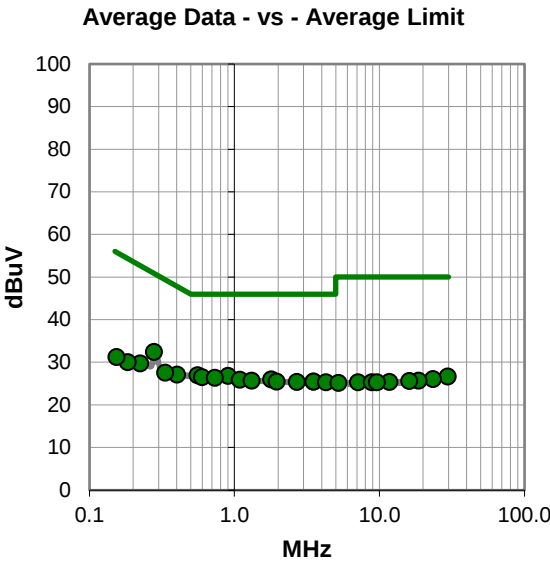
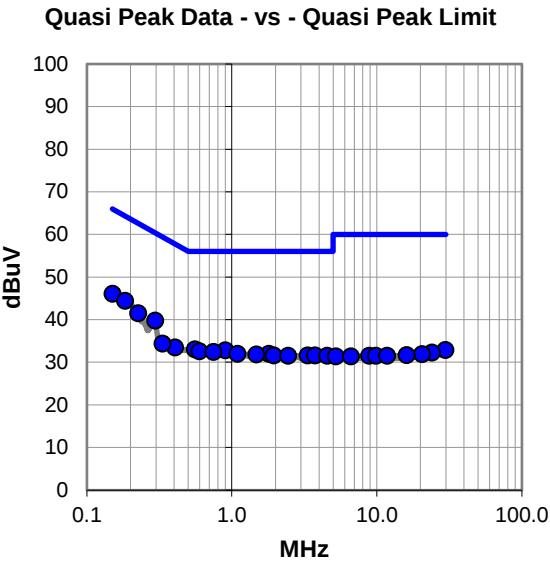
None

EUT OPERATING MODES

24 GHz Transmitting Sweeping FMCW

DEVIATIONS FROM TEST STANDARD

None



POWERLINE CONDUCTED EMISSIONS

RESULTS - Run #3

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.150	25.0	21.1	46.1	66.0	-19.9
0.184	23.4	21.0	44.4	64.3	-19.9
0.295	19.2	20.6	39.8	60.4	-20.6
0.226	20.7	20.8	41.5	62.6	-21.1
0.554	12.3	20.7	33.0	56.0	-23.0
0.899	12.1	20.7	32.8	56.0	-23.2
0.597	11.9	20.7	32.6	56.0	-23.4
0.747	11.6	20.8	32.4	56.0	-23.6
1.093	11.3	20.7	32.0	56.0	-24.0
1.796	11.3	20.7	32.0	56.0	-24.0
1.479	11.1	20.7	31.8	56.0	-24.2
0.405	12.9	20.6	33.5	57.8	-24.3
1.946	10.9	20.7	31.6	56.0	-24.4
3.324	10.7	20.9	31.6	56.0	-24.4
3.736	10.7	20.9	31.6	56.0	-24.4
2.448	10.8	20.7	31.5	56.0	-24.5
4.547	10.6	20.9	31.5	56.0	-24.5
0.332	13.8	20.6	34.4	59.4	-25.0
29.670	10.0	22.9	32.9	60.0	-27.1
23.963	10.0	22.3	32.3	60.0	-27.7
20.437	10.0	21.9	31.9	60.0	-28.1
16.084	10.0	21.7	31.7	60.0	-28.3
8.855	10.4	21.1	31.5	60.0	-28.5
9.827	10.3	21.2	31.5	60.0	-28.5
11.763	10.1	21.4	31.5	60.0	-28.5

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.278	11.8	20.6	32.4	50.9	-18.5
0.554	6.3	20.7	27.0	46.0	-19.0
0.899	6.1	20.7	26.8	46.0	-19.2
0.597	5.8	20.7	26.5	46.0	-19.5
0.731	5.6	20.8	26.4	46.0	-19.6
1.795	5.3	20.7	26.0	46.0	-20.0
1.085	5.2	20.7	25.9	46.0	-20.1
1.311	5.0	20.7	25.7	46.0	-20.3
1.950	4.8	20.7	25.5	46.0	-20.5
3.498	4.6	20.9	25.5	46.0	-20.5
3.510	4.6	20.9	25.5	46.0	-20.5
2.694	4.7	20.7	25.4	46.0	-20.6
0.402	6.5	20.6	27.1	47.8	-20.7
4.273	4.4	20.9	25.3	46.0	-20.7
0.332	7.0	20.6	27.6	49.4	-21.8
0.223	8.9	20.8	29.7	52.7	-23.0
29.597	3.8	22.9	26.7	50.0	-23.3
23.435	3.9	22.2	26.1	50.0	-23.9
0.184	9.0	21.0	30.0	54.3	-24.3
18.573	3.9	21.8	25.7	50.0	-24.3
16.079	3.9	21.7	25.6	50.0	-24.4
0.153	10.1	21.1	31.2	55.8	-24.6
11.728	4.0	21.4	25.4	50.0	-24.6
7.118	4.3	21.0	25.3	50.0	-24.7
8.841	4.2	21.1	25.3	50.0	-24.7

CONCLUSION

Pass



Tested By

POWERLINE CONDUCTED EMISSIONS



EUT:	MR24 Radar FDS Sensor	Work Order:	BANN0742
Serial Number:	RD2507007	Date:	2025-09-16
Customer:	Banner Engineering Corp.	Temperature:	22.6°C
Attendees:	Kevin Kruse	Relative Humidity:	57.4%
Customer Project:	None	Bar. Pressure (PMSL):	1018 mb
Tested By:	Arnauld Dedry	Job Site:	MN05
Power:	110VAC/60Hz	Configuration:	BANN0742-1

TEST PARAMETERS

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

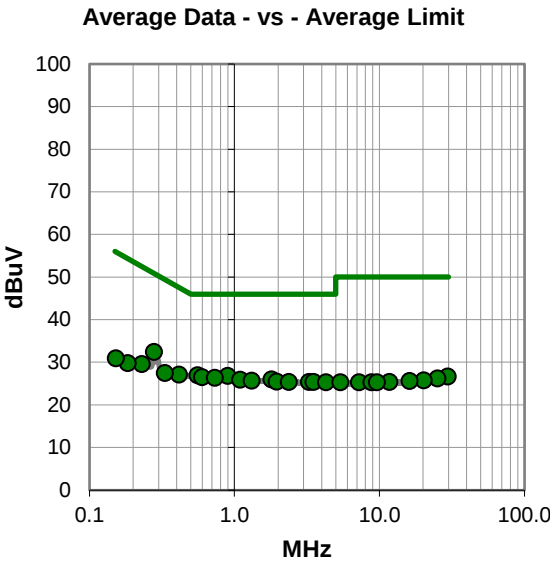
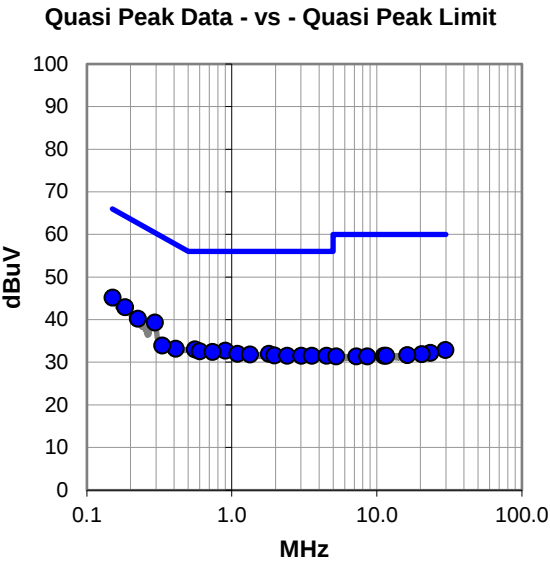
None

EUT OPERATING MODES

24 GHz Transmitting, CW Mid Ch 24.12 GHz
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DEVIATIONS FROM TEST STANDARD

None



POWERLINE CONDUCTED EMISSIONS

RESULTS - Run #4

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.150	24.1	21.1	45.2	66.0	-20.8
0.293	18.7	20.6	39.3	60.4	-21.1
0.184	21.9	21.0	42.9	64.3	-21.4
0.225	19.4	20.8	40.2	62.6	-22.4
0.556	12.3	20.7	33.0	56.0	-23.0
0.899	12.0	20.7	32.7	56.0	-23.3
0.599	11.9	20.7	32.6	56.0	-23.4
0.736	11.6	20.8	32.4	56.0	-23.6
1.093	11.3	20.7	32.0	56.0	-24.0
1.796	11.3	20.7	32.0	56.0	-24.0
1.336	11.1	20.7	31.8	56.0	-24.2
1.960	10.9	20.7	31.6	56.0	-24.4
0.409	12.6	20.6	33.2	57.7	-24.5
2.404	10.8	20.7	31.5	56.0	-24.5
3.012	10.8	20.7	31.5	56.0	-24.5
3.557	10.6	20.9	31.5	56.0	-24.5
4.495	10.6	20.9	31.5	56.0	-24.5
0.330	13.3	20.6	33.9	59.5	-25.6
29.725	10.0	22.9	32.9	60.0	-27.1
23.362	10.0	22.2	32.2	60.0	-27.8
20.355	10.0	21.9	31.9	60.0	-28.1
16.206	10.0	21.7	31.7	60.0	-28.3
11.160	10.2	21.3	31.5	60.0	-28.5
11.609	10.2	21.3	31.5	60.0	-28.5
5.251	10.5	20.9	31.4	60.0	-28.6

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.278	11.8	20.6	32.4	50.9	-18.5
0.554	6.3	20.7	27.0	46.0	-19.0
0.898	6.1	20.7	26.8	46.0	-19.2
0.597	5.8	20.7	26.5	46.0	-19.5
0.731	5.6	20.8	26.4	46.0	-19.6
1.796	5.3	20.7	26.0	46.0	-20.0
1.093	5.2	20.7	25.9	46.0	-20.1
1.311	5.0	20.7	25.7	46.0	-20.3
0.414	6.4	20.7	27.1	47.6	-20.5
1.950	4.8	20.7	25.5	46.0	-20.5
2.369	4.7	20.7	25.4	46.0	-20.6
3.260	4.6	20.8	25.4	46.0	-20.6
3.508	4.5	20.9	25.4	46.0	-20.6
4.273	4.4	20.9	25.3	46.0	-20.7
0.330	6.9	20.6	27.5	49.5	-22.0
0.229	8.9	20.7	29.6	52.5	-22.9
29.597	3.8	22.9	26.7	50.0	-23.3
25.050	3.9	22.3	26.2	50.0	-23.8
20.137	3.9	21.9	25.8	50.0	-24.2
16.154	3.9	21.7	25.6	50.0	-24.4
0.184	8.8	21.0	29.8	54.3	-24.5
11.729	4.0	21.4	25.4	50.0	-24.6
5.388	4.4	20.9	25.3	50.0	-24.7
7.227	4.3	21.0	25.3	50.0	-24.7
8.814	4.2	21.1	25.3	50.0	-24.7

CONCLUSION

Pass



Tested By

POWERLINE CONDUCTED EMISSIONS



EUT:	MR24 Radar FDS Sensor	Work Order:	BANN0742
Serial Number:	RD2507007	Date:	2025-09-16
Customer:	Banner Engineering Corp.	Temperature:	22.6°C
Attendees:	Kevin Kruse	Relative Humidity:	57.4%
Customer Project:	None	Bar. Pressure (PMSL):	1018 mb
Tested By:	Arnauld Dedry	Job Site:	MN05
Power:	110VAC/60Hz	Configuration:	BANN0742-1

TEST PARAMETERS

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

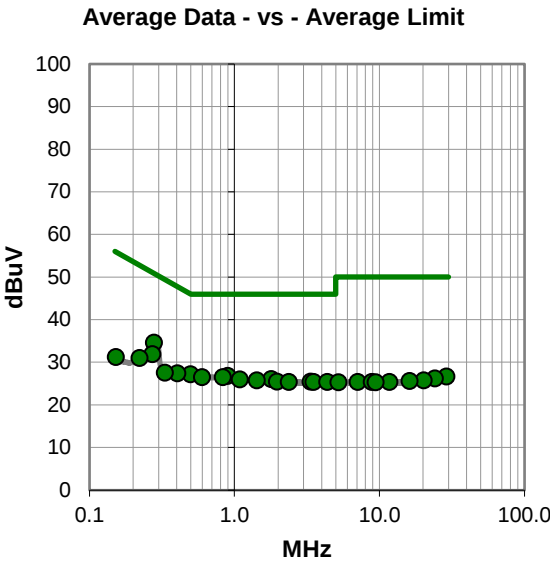
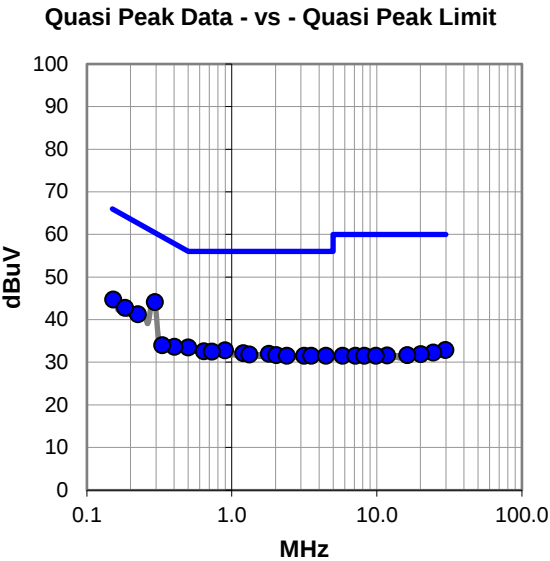
None

EUT OPERATING MODES

24 GHz Transmitting, CW Mid Ch 24.12 GHz
--

DEVIATIONS FROM TEST STANDARD

None



POWERLINE CONDUCTED EMISSIONS

RESULTS - Run #5

Quasi Peak Data - vs - Quasi Peak Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.293	23.5	20.6	44.1	60.4	-16.3
0.152	23.6	21.1	44.7	65.9	-21.2
0.225	20.5	20.8	41.3	62.6	-21.3
0.184	21.8	21.0	42.8	64.3	-21.5
0.499	12.8	20.7	33.5	56.0	-22.5
0.896	12.1	20.7	32.8	56.0	-23.2
0.640	11.8	20.8	32.6	56.0	-23.4
0.727	11.7	20.8	32.5	56.0	-23.5
1.198	11.4	20.7	32.1	56.0	-23.9
1.796	11.3	20.7	32.0	56.0	-24.0
0.402	13.0	20.6	33.6	57.8	-24.2
1.319	11.1	20.7	31.8	56.0	-24.2
2.019	11.0	20.7	31.7	56.0	-24.3
2.393	10.8	20.7	31.5	56.0	-24.5
3.144	10.7	20.8	31.5	56.0	-24.5
3.522	10.6	20.9	31.5	56.0	-24.5
4.450	10.6	20.9	31.5	56.0	-24.5
0.330	13.4	20.6	34.0	59.5	-25.5
29.737	10.0	22.9	32.9	60.0	-27.1
24.538	10.0	22.3	32.3	60.0	-27.7
20.124	10.0	21.9	31.9	60.0	-28.1
16.217	10.0	21.7	31.7	60.0	-28.3
11.783	10.2	21.4	31.6	60.0	-28.4
5.792	10.6	20.9	31.5	60.0	-28.5
7.114	10.5	21.0	31.5	60.0	-28.5

Average Data - vs - Average Limit

Freq (MHz)	Amp. (dBuV)	Factor (dB)	Adjusted (dBuV)	Spec. Limit (dBuV)	Margin (dB)
0.278	14.0	20.6	34.6	50.9	-16.3
0.496	6.5	20.7	27.2	46.1	-18.9
0.271	11.2	20.7	31.9	51.1	-19.2
0.898	6.1	20.7	26.8	46.0	-19.2
0.597	5.8	20.7	26.5	46.0	-19.5
0.831	5.8	20.7	26.5	46.0	-19.5
1.795	5.4	20.7	26.1	46.0	-19.9
1.090	5.3	20.7	26.0	46.0	-20.0
1.421	5.1	20.7	25.8	46.0	-20.2
0.403	6.8	20.6	27.4	47.8	-20.4
1.966	4.8	20.7	25.5	46.0	-20.5
3.348	4.6	20.9	25.5	46.0	-20.5
2.365	4.7	20.7	25.4	46.0	-20.6
3.508	4.5	20.9	25.4	46.0	-20.6
4.360	4.5	20.9	25.4	46.0	-20.6
0.222	10.2	20.8	31.0	52.8	-21.8
0.330	7.0	20.6	27.6	49.5	-21.9
28.951	3.9	22.8	26.7	50.0	-23.3
24.075	3.9	22.3	26.2	50.0	-23.8
20.196	3.9	21.9	25.8	50.0	-24.2
16.157	3.9	21.7	25.6	50.0	-24.4
7.068	4.4	21.0	25.4	50.0	-24.6
8.827	4.3	21.1	25.4	50.0	-24.6
11.726	4.0	21.4	25.4	50.0	-24.6
0.152	10.1	21.1	31.2	55.9	-24.7

CONCLUSION

Pass



Tested By

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

TEST DESCRIPTION

For each configuration, the spectrum was scanned throughout the specified range as part of the exploratory investigation of the emissions. A reference preview scan (pre-scan) is 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).

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 = CISPR Avg. 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.

47 CFR 15.249(d):

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

Fundamental (dBuV/m)	F (MHz)	30-88	88-216	216-960	960+
	15.209 limits (dBuV/m)	40	43.5	46	54
102.8	-50 dBc (dBuV/m)	52.8	52.8	52.8	52.8

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	2025-04-11	2026-04-11
Antenna - Standard Gain	A.H. Systems, Inc.	SAS-588	AJO	2025-02-04	2026-02-04
Antenna - Standard Gain	ETS Lindgren	3160-09	AHG	2025-02-04	2026-02-04
Antenna - Standard Gain	ETS Lindgren	3160-08	AIQ	2025-02-04	2026-02-04
Antenna - Standard Gain	ETS Lindgren	3160-07	AXP	NCR	NCR
Antenna - Double Ridge	ETS Lindgren	3115	AIP	2024-08-02	2026-08-02
Antenna - Biconilog	Teseq	CBL 6141B	AYD	2024-03-18	2026-03-18
Antenna - Loop	ETS Lindgren	6502	AOB	2025-06-17	2027-06-17
Cable	Fairview Microwave	FMCA1975-200CM	MN1	2025-04-14	2026-04-14
Cable	ESM Cable Corp.	TTBJ141 KMKM-72	MNP	2025-09-04	2026-09-04
Cable	ESM Cable Corp.	Standard Gain Horn Cables	MNJ	2024-11-26	2025-11-26
Cable	ESM Cable Corp.	Double Ridge Guide Horn Cables	MNI	2024-11-26	2025-11-26
Cable	ESM Cable Corp.	Bilog Cables	MNH	2024-11-26	2025-11-26
Amplifier - Pre-Amplifier	Narda Miteq	JSW45-26004000-40-5P	PBC	2025-04-14	2026-04-14
Amplifier - Pre-Amplifier	Miteq	JSD4-18002600-26-8P	APU	2025-09-04	2026-09-04
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AVW	2025-01-08	2026-01-08
Amplifier - Pre-Amplifier	Miteq	AMF-6F-08001200-30-10P	AVV	2025-01-08	2026-01-08
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	AVT	2025-01-08	2026-01-08
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AVO	2024-10-09	2025-10-09

FREQUENCY RANGE INVESTIGATED

9 kHz TO 40 GHz

POWER INVESTIGATED

110VAC/60Hz

CONFIGURATIONS INVESTIGATED

BANN0742-1

MODES INVESTIGATED

CW Low = 24.01 GHz, Mid = 24.13 GHz, High = 24.24 GHz

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS



EUT:	MR24 Radar FDS Sensor	Work Order:	BANN0742
Serial Number:	RD2507007	Date:	2025-09-16
Customer:	Banner Engineering Corp.	Temperature:	22.6°C
Attendees:	Kevin Kruse	Relative Humidity:	57.2%
Customer Project:	None	Bar. Pressure (PMSL):	1019 mb
Tested By:	Arnauld Dedry	Job Site:	MN05
Power:	110VAC/60Hz	Configuration:	BANN0742-1

TEST PARAMETERS

Run #:	23	Test Distance (m):	3	Ant. Height(s) (m):	1 to 4(m)
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COMMENTS

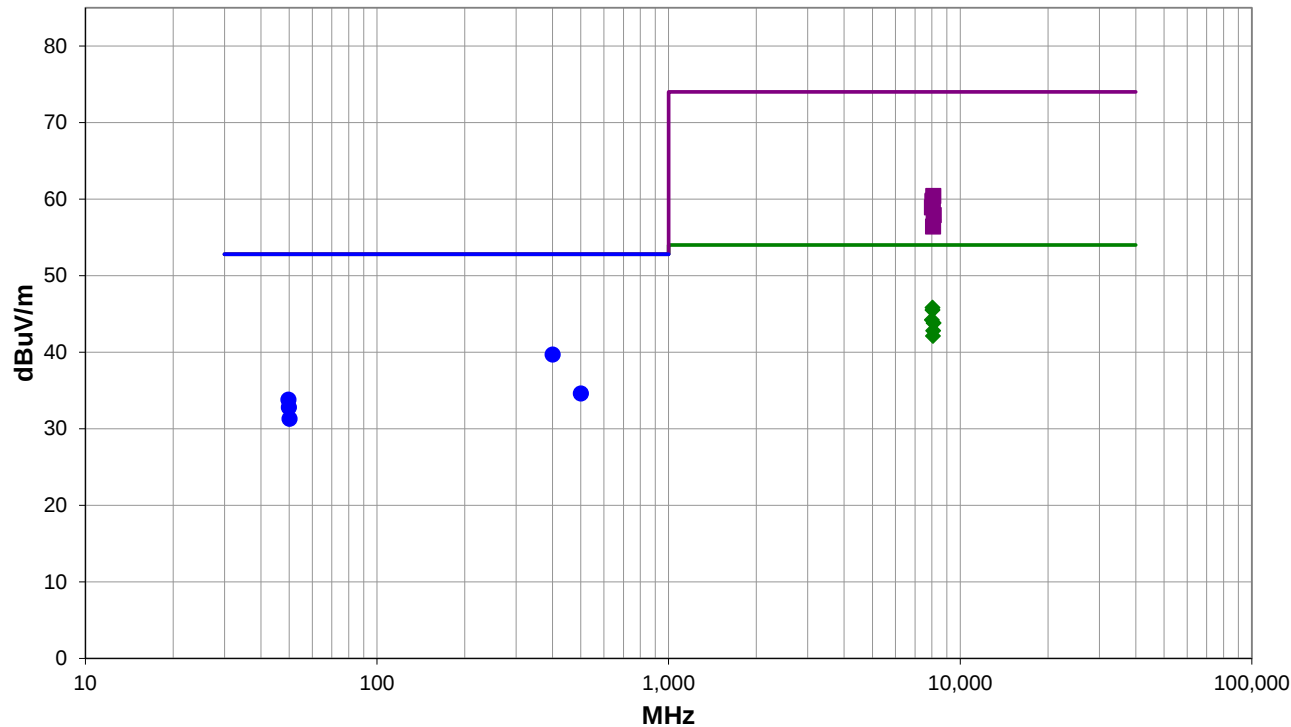
None

EUT OPERATING MODES

CW Low = 24.01 GHz, Mid = 24.13 GHz, High = 24.24 GHz

DEVIATIONS FROM TEST STANDARD

None



Run #: 23

■ PK ◆ AV ● QP

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

RESULTS - Run #23

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)	Comments
8043.483	27.9	17.9	1.9	237.0	3.0	0.0	Vert	AV	0.0	45.8	54.0	-8.2	Mid - EUT Horz
8043.417	27.6	17.9	2.1	346.0	3.0	0.0	Horz	AV	0.0	45.5	54.0	-8.5	Mid - EUT Vert
8006.783	26.6	17.6	2.3	7.0	3.0	0.0	Vert	AV	0.0	44.2	54.0	-9.8	Low - EUT Horz
8110.483	25.6	18.2	2.3	332.0	3.0	0.0	Horz	AV	0.0	43.8	54.0	-10.2	High - EUT Vert
8085.467	24.7	18.1	2.3	335.0	3.0	0.0	Vert	AV	0.0	42.8	54.0	-11.2	High - EUT Horz
8068.283	24.1	18.0	2.8	170.0	3.0	0.0	Horz	AV	0.0	42.1	54.0	-11.9	Low - EUT Vert
400.085	34.9	4.8	1.0	358.0	3.0	0.0	Vert	QP	0.0	39.7	52.8	-13.1	Mid - EUT Horz
8088.258	42.3	18.1	2.3	335.0	3.0	0.0	Vert	PK	0.0	60.4	74.0	-13.6	High - EUT Horz
8043.500	41.9	17.9	1.9	237.0	3.0	0.0	Vert	PK	0.0	59.8	74.0	-14.2	Mid - EUT Horz
8043.767	41.8	17.9	2.1	346.0	3.0	0.0	Horz	PK	0.0	59.7	74.0	-14.3	Mid - EUT Vert
8004.500	41.3	17.6	2.3	7.0	3.0	0.0	Vert	PK	0.0	58.9	74.0	-15.1	Low - EUT Horz
8105.608	39.7	18.2	2.3	332.0	3.0	0.0	Horz	PK	0.0	57.9	74.0	-16.1	High - EUT Vert
8070.275	38.4	18.0	2.8	170.0	3.0	0.0	Horz	PK	0.0	56.4	74.0	-17.6	Low - EUT Vert
500.106	27.8	6.8	1.9	21.0	3.0	0.0	Horz	QP	0.0	34.6	52.8	-18.2	Mid - EUT on Side
49.663	35.2	-1.4	1.0	295.0	3.0	0.0	Vert	QP	0.0	33.8	52.8	-19.0	Low - EUT Horz
49.884	34.3	-1.5	1.0	346.0	3.0	0.0	Vert	QP	0.0	32.8	52.8	-20.0	Mid - EUT Horz
50.145	32.9	-1.6	1.0	275.0	3.0	0.0	Vert	QP	0.0	31.3	52.8	-21.5	High - EUT Horz

CONCLUSION

Pass



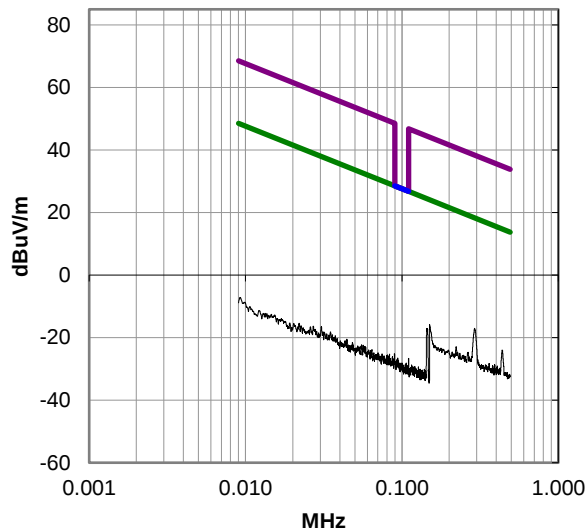
Tested By

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

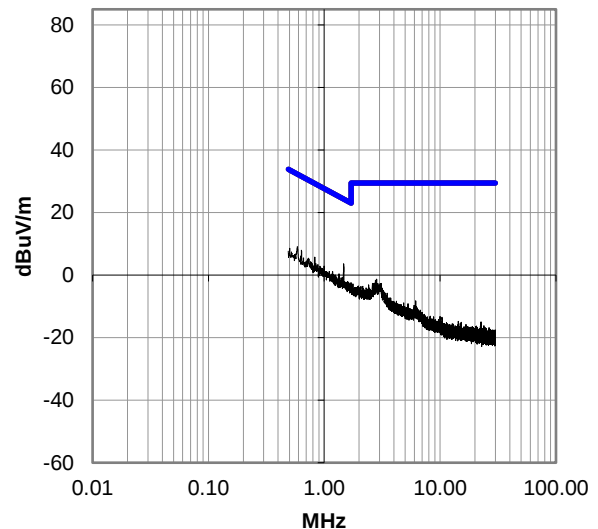
PRESCAN DATA

Radiated spurious emissions from the EUT are initially reviewed with Pre-scans (Preview scans). Pre-scans are performed, with the EUT transmitting on the lowest applicable data rate, for both vertical and horizontal polarizations. The Pre-scan plots below are shown with a peak detector and RBW for the following frequency ranges: 9 kHz RBW (< 30 MHz); 120 kHz RBW (30 - 1000 MHz); 1 MHz RBW (> 1 GHz). In the case where unintentional emissions are observed, an ambient or idle pre-scan with the radio off, will be shown for comparison.

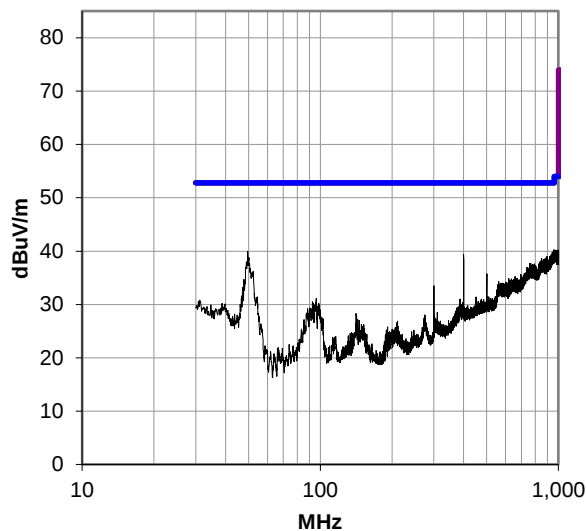
0.009-0.49 MHz, Run 36



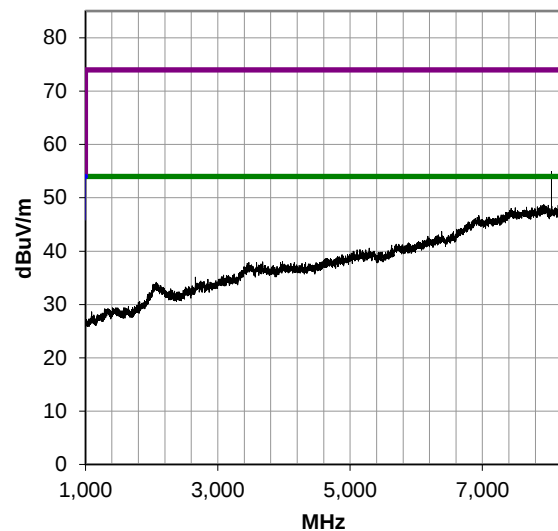
0.49-30 MHz, Run 37



30-1000 MHz, Run 31

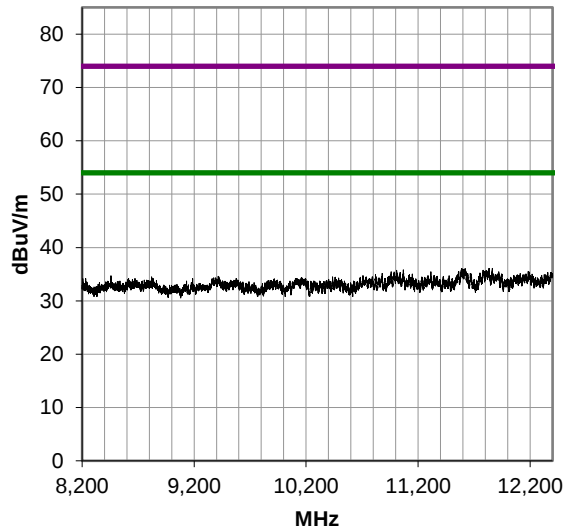


1000-8200 MHz, Run 22

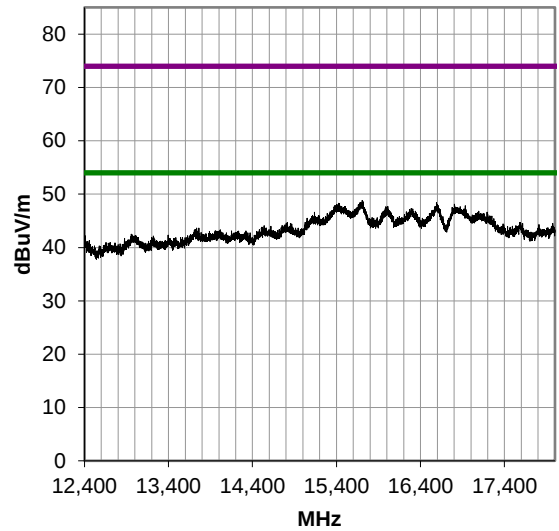


FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS

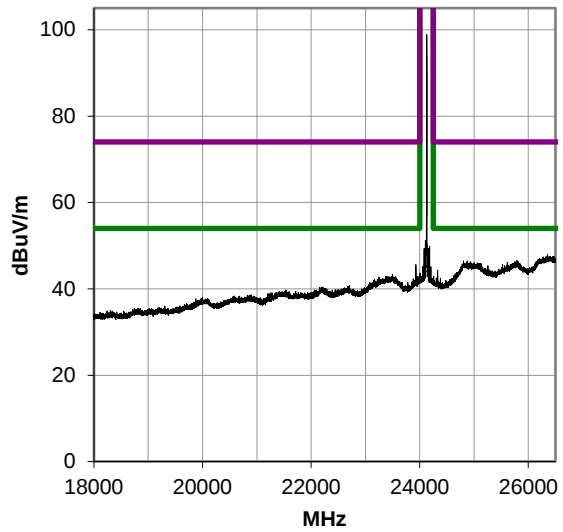
8200-12400 MHz, Run 24



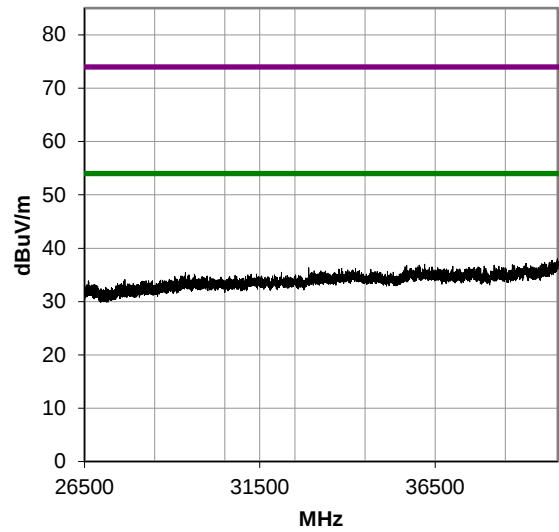
12400-18000 MHz, Run 25



18000-26500 MHz, Run 6



26500-40000 MHz, Run 13



FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS ABOVE 40 GHz



TEST DESCRIPTION

The spectrum was scanned throughout the specified range as part of the exploratory investigation of the emissions. A reference preview scan (pre-scan) is 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). 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 performed at distance that is closer than the specified distance were corrected to the specified distance using a 20 dB/decade distance correction factor.

$$\text{Correction factor} = 20 \cdot \log(d_{\text{meas}} / d_{\text{spec}})$$

ANSI C63.10, section 9.1.4: All measurements shall be made in the far-field of the measurement antenna. The far-field boundary for mm-wave antennas is $2D^2/\lambda$, where D is the largest antenna dimension.

Antenna	D (cm)	freq (GHz)	λ (mm)	Far Field Boundary (cm)	Measurement Distance (cm)	Spec. Distance (cm)	Distance correction factor (dB)
M19RH	4.6	40	7.50	56.4	100	300	-9.5
	4.6	60	5.00	84.6			
M12RH	3	60	5.00	36.0	60		-14
	3	90	3.33	54.0			
M80RH	1.9	90	3.33	21.7	40		-17.5
	1.9	100	3.00	24.1			

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

PK = Peak Detector
AV = CISPR Avg Detector

47 CFR 15.249(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

Fund. (dBuV/m)	F (MHz)	30-88	88-216	216-960	960+
	15.209 limits(dBuV/m)	40	43.5	46	54
102.8	-50 dBc (dBuV/m)	52.8	52.8	52.8	52.8

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

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Antenna - Standard Gain	OML, Inc.	M19RH	AZT	2025-02-04	2026-02-04
Antenna - Standard Gain	OML, Inc.	M12RH	AZU	2025-02-04	2026-02-04
Antenna - Standard Gain	OML, Inc.	M80RH	AZV	2025-02-04	2026-02-04
Spectrum Analyzer Extension Module	Virginia Diodes, Inc.	WR19SAX	AFT	2024-04-30	2027-04-30
Spectrum Analyzer Extension Module	Virginia Diodes, Inc.	WR12SAX	AFU	2024-04-30	2027-04-30
Spectrum Analyzer Extension Module	Virginia Diodes, Inc.	WR8.0SAX	AFV	2024-04-30	2027-04-30
Cable	Micro-Coax	UFD150A-1-0720-200200	EVI	2024-12-03	2025-12-03
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	2024-11-25	2025-11-25

FREQUENCY RANGE INVESTIGATED

40 GHz TO 100 GHz

POWER INVESTIGATED

24VDC via 110VAC/60Hz

CONFIGURATIONS INVESTIGATED

BANN0742-2

MODES INVESTIGATED

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS ABOVE 40 GHz



CW Low = 24.02 GHz, Mid = 24.13 GHz, High = 24.24 GHz

EUT:	MR24 Radar FDS Sensor	Work Order:	BANN0742
Serial Number:	RD2507007	Date:	2025-11-21
Customer:	Banner Engineering Corp.	Temperature:	21.2°C
Attendees:	None	Relative Humidity:	37%
Customer Project:	None	Bar. Pressure (PMSL):	1025 mb
Tested By:	Jeff Alcock	Job Site:	EV01
Power:	24VDC via 110VAC/60Hz	Configuration:	BANN0742-2

TEST PARAMETERS

Run #:	92	Test Distance (m):	1.0 (40 – 60 GHz) 0.6 (60 – 90 GHz) 0.4 (90 – 100 GHz)	Ant. Height(s) (m):	1 to 1.8(m)
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COMMENTS

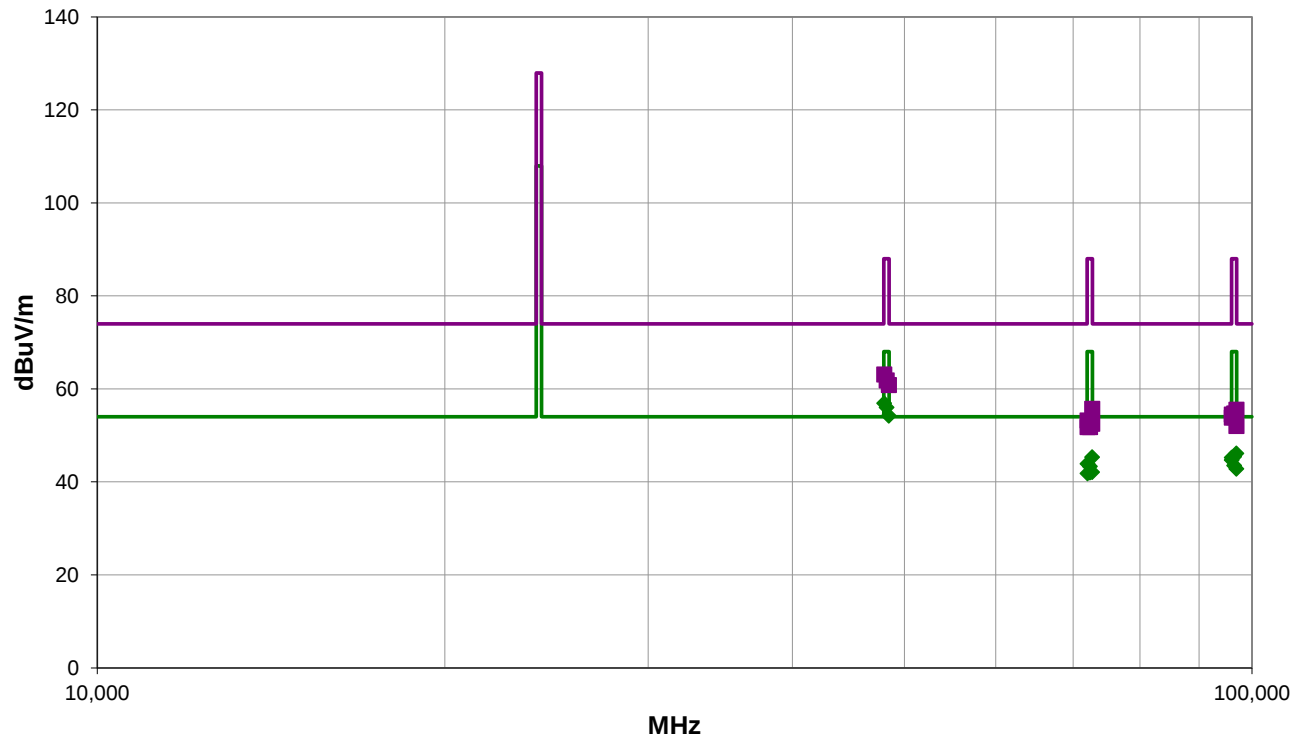
Measurements performed on the EUT's worst case orientation.

EUT OPERATING MODES

CW Low = 24.01 GHz, Mid = 24.13 GHz, High = 24.24 GHz

DEVIATIONS FROM TEST STANDARD

None



Run #: 92

■ PK ◆ AV ● QP

FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS ABOVE 40 GHz

RESULTS - Run #92

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)	Comments
48040.430	26.7	39.7	1.44	358.0	1.0	0.0	Vert	AV	-9.5	56.9	68.0	-11.1	Low, EUT Horz
48260.500	25.8	39.7	1.44	358.0	1.0	0.0	Vert	AV	-9.5	56.0	68.0	-12.0	Mid, EUT Horz
48478.490	23.9	39.8	1.43	340.0	1.0	0.0	Vert	AV	-9.5	54.2	68.0	-13.8	High, EUT Horz
48040.120	32.9	39.7	1.44	358.0	1.0	0.0	Vert	PK	-9.5	63.1	88.0	-24.9	Low, EUT Horz
48259.580	31.6	39.7	1.44	358.0	1.0	0.0	Vert	PK	-9.5	61.8	88.0	-26.2	Mid, EUT Horz
48478.670	30.5	39.8	1.43	340.0	1.0	0.0	Vert	PK	-9.5	60.8	88.0	-27.2	High, EUT Horz
72717.660	16.0	43.3	1.38	332.0	0.6	0.0	Vert	AV	-14.0	45.3	68.0	-22.7	High, EUT Horz
72060.630	14.7	43.2	1.39	355.0	0.6	0.0	Vert	AV	-14.0	43.9	68.0	-24.1	Low, EUT Horz
72390.710	14.1	43.2	1.38	334.0	0.6	0.0	Vert	AV	-14.0	43.3	68.0	-24.7	Mid, EUT Horz
72717.660	26.4	43.3	1.38	332.0	0.6	0.0	Vert	PK	-14.0	55.7	88.0	-32.3	High, EUT Horz
72060.340	24.0	43.2	1.39	355.0	0.6	0.0	Vert	PK	-14.0	53.2	88.0	-34.8	Low, EUT Horz
72390.220	23.7	43.2	1.38	334.0	0.6	0.0	Vert	PK	-14.0	52.9	88.0	-35.1	Mid, EUT Horz
96080.770	16.9	45.8	1.39	14.0	0.4	0.0	Vert	AV	-17.5	45.2	68.0	-22.8	Low, EUT Horz
96520.880	15.2	45.8	1.39	14.0	0.4	0.0	Vert	AV	-17.5	43.5	68.0	-24.5	Mid, EUT Horz
96957.000	14.5	45.8	1.4	349.0	0.4	0.0	Vert	AV	-17.5	42.8	68.0	-25.2	High, EUT Horz
96081.040	26.2	45.8	1.39	14.0	0.4	0.0	Vert	PK	-17.5	54.5	88.0	-33.5	Low, EUT Horz
96521.630	25.6	45.8	1.39	14.0	0.4	0.0	Vert	PK	-17.5	53.9	88.0	-34.1	Mid, EUT Horz
96955.320	23.7	45.8	1.4	349.0	0.4	0.0	Vert	PK	-17.5	52.0	88.0	-36.0	High, EUT Horz
96956.850	17.8	45.8	1.43	352.0	0.4	0.0	Horz	AV	-17.5	46.1	68.0	-21.9	High, EUT Vert
96520.810	17.1	45.8	1.43	352.0	0.4	0.0	Horz	AV	-17.5	45.4	68.0	-22.6	Mid, EUT Vert
96080.780	16.4	45.8	1.43	352.0	0.4	0.0	Horz	AV	-17.5	44.7	68.0	-23.3	Low, EUT Vert
96956.560	27.2	45.8	1.43	352.0	0.4	0.0	Horz	PK	-17.5	55.5	88.0	-32.5	High, EUT Vert
96520.870	26.4	45.8	1.43	352.0	0.4	0.0	Horz	PK	-17.5	54.7	88.0	-33.3	Mid, EUT Vert
96080.530	25.5	45.8	1.43	352.0	0.4	0.0	Horz	PK	-17.5	53.8	88.0	-34.2	Low, EUT Vert
72715.660	12.8	43.3	1.49	0.0	0.6	0.0	Horz	AV	-14.0	42.1	68.0	-25.9	High, EUT Vert
72390.550	12.8	43.2	1.49	0.0	0.6	0.0	Horz	AV	-14.0	42.0	68.0	-26.0	Mid, EUT Vert
72060.710	12.6	43.2	1.49	0.0	0.6	0.0	Horz	AV	-14.0	41.8	68.0	-26.2	Low, EUT Vert
72719.170	23.2	43.3	1.49	0.0	0.6	0.0	Horz	PK	-14.0	52.5	88.0	-35.5	High, EUT Vert
72392.030	22.6	43.2	1.49	0.0	0.6	0.0	Horz	PK	-14.0	51.8	88.0	-36.2	Mid, EUT Vert
72061.820	22.6	43.2	1.49	0.0	0.6	0.0	Horz	PK	-14.0	51.8	88.0	-36.2	Low, EUT Vert

CONCLUSION

Pass

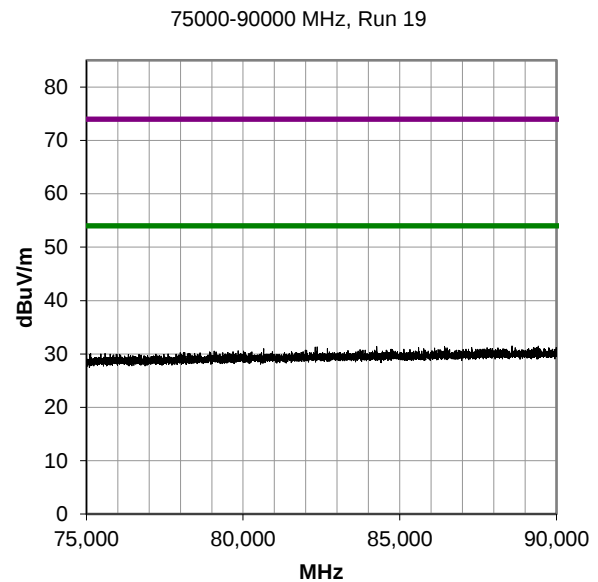
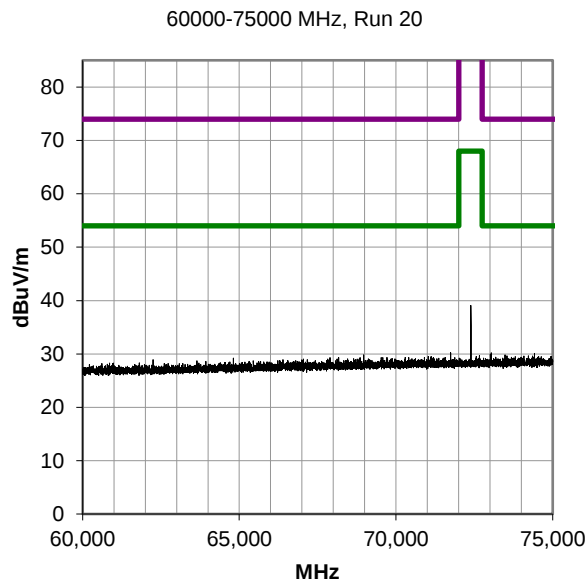
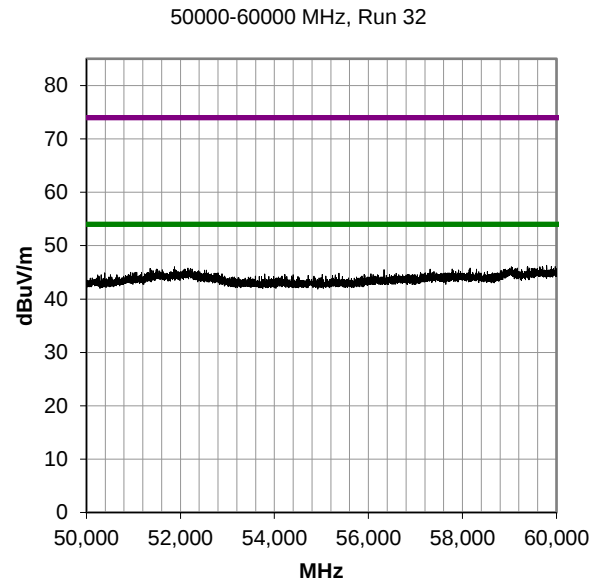
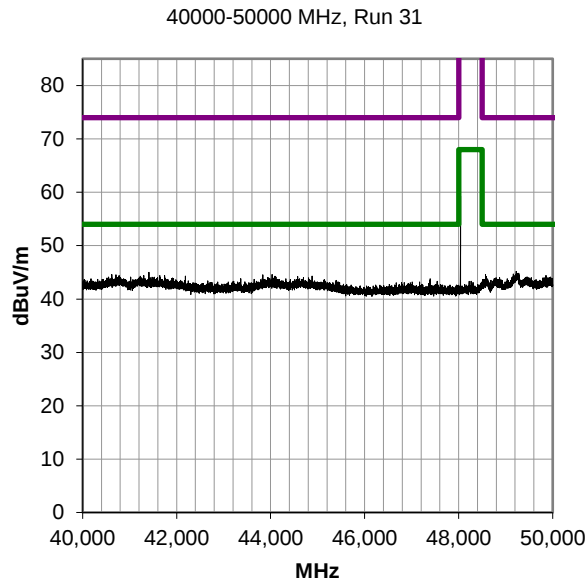


Tested By

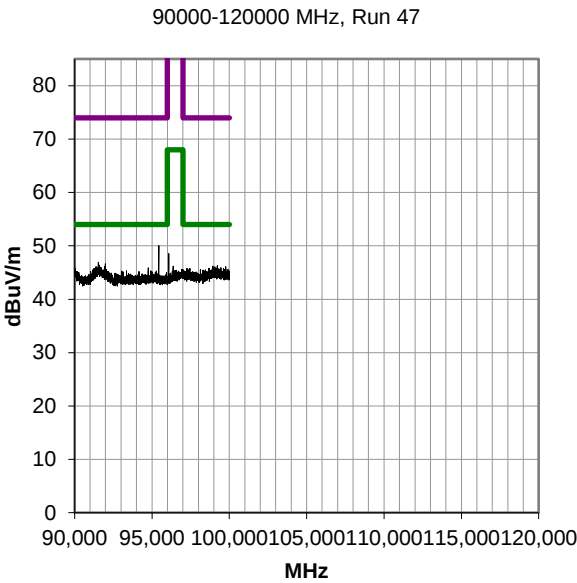
FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS ABOVE 40 GHz

PRESCAN DATA

Radiated spurious emissions from the EUT are initially reviewed with Pre-scans (Preview scans). Pre-scans are performed, with the EUT transmitting on the lowest applicable data rate, for both vertical and horizontal polarizations. The Pre-scan plots below are shown with a peak detector and RBW for the following frequency ranges: 9 kHz RBW (< 30 MHz); 120 kHz RBW (30 - 1000 MHz); 1 MHz RBW (> 1 GHz). In the case where unintentional emissions are observed, an ambient or idle pre-scan with the radio off, will be shown for comparison.



FIELD STRENGTH OF HARMONICS AND SPURIOUS RADIATED EMISSIONS ABOVE 40 GHz



RADIATED BAND EDGE EMISSIONS

TEST DESCRIPTION

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). Worst case orientation is reported.

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

PK = Peak Detector

AV = CISPR Avg Detector

Measurements performed at distance that is closer than the specified distance were corrected to the specified distance using a 20 dB/decade distance correction factor.

$$\text{Correction factor} = 20 \cdot \log(d_{\text{meas}} / d_{\text{spec}})$$

ANSI C63.10, section 9.1.4: All measurements shall be made in the far-field of the measurement antenna. The far-field boundary for mm-wave antennas is $2D^2 / \lambda$, where D is the largest antenna dimension.

Antenna	D (cm)	freq (GHz)	λ (mm)	Far Field Boundary (cm)	Measurement Distance (cm)	Spec. distance (cm)	Distance Correction Factor (dB)
3160-09	3.87	23.50	12.77	23.5	80	300	-11.5
	3.87	24.75	12.12	24.7			

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	2024-11-25	2025-11-25
Antenna - Standard Gain	ETS Lindgren	3160-09	AIV	2025-01-23	2026-01-23
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	EVY	2025-04-27	2026-04-27
Amplifier - Pre-Amplifier	Miteq	AMF-6F-18002650-25-10P	AVU	2025-04-27	2026-04-27

FREQUENCY RANGE INVESTIGATED

23.50 GHz TO 24.75 GHz

POWER INVESTIGATED

24VDC via 110VAC/60Hz

CONFIGURATIONS INVESTIGATED

BANN0742-2

MODES INVESTIGATED

CW Low = 24.02 GHz and High = 24.24 GHz

RADIATED BAND EDGE EMISSIONS

EUT:	MR24 Radar FDS Sensor	Work Order:	BANN0742
Serial Number:	RD2507007	Date:	2025-11-13
Customer:	Banner Engineering Corp.	Temperature:	20.4°C
Attendees:	None	Relative Humidity:	0.526%
Customer Project:	None	Bar. Pressure (PMSL):	1004 mb
Tested By:	Jeff Alcock	Job Site:	EV01
Power:	24VDC via 110VAC/60Hz	Configuration:	BANN0742-2

TEST PARAMETERS

Run #:	58	Test Distance (m):	0.8	Ant. Height(s) (m):	1 to 4(m)
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COMMENTS

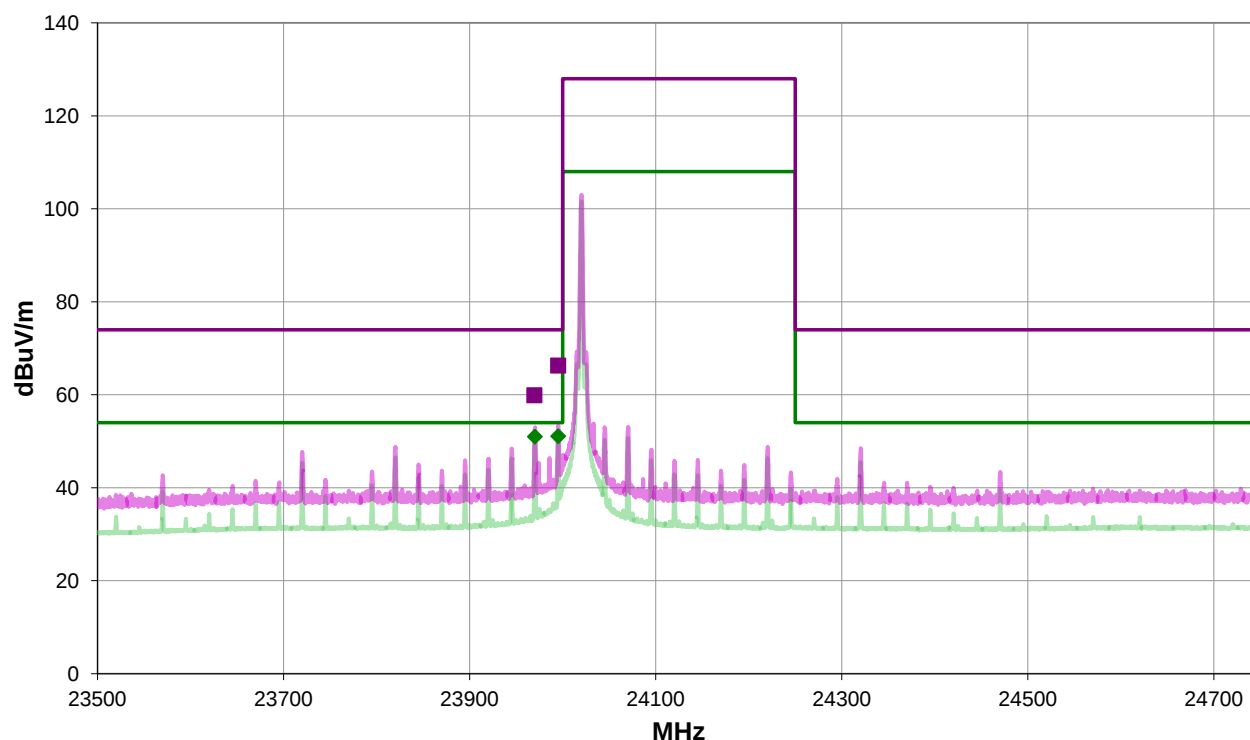
Measurements performed on the EUT's worst case orientation.

EUT OPERATING MODES

CW Low = 24.02 GHz

DEVIATIONS FROM TEST STANDARD

None



Run #: 58

■ PK ◆ AV ● QP

RADIATED BAND EDGE EMISSIONS

RESULTS - Run #58

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)
23995.180	52.8	9.8	1.5	0.0	0.8	0.0	Horz	AV	-11.5	51.1	54.0	-2.9
23970.150	52.7	9.8	1.5	0.0	0.8	0.0	Horz	AV	-11.5	51.0	54.0	-3.0
23995.090	68.0	9.8	1.5	0.0	0.8	0.0	Horz	PK	-11.5	66.3	74.0	-7.7
23969.520	61.6	9.8	1.5	0.0	0.8	0.0	Horz	PK	-11.5	59.9	74.0	-14.1

CONCLUSION

Pass



Tested By

RADIATED BAND EDGE EMISSIONS

EUT:	MR24 Radar FDS Sensor	Work Order:	BANN0742
Serial Number:	RD2507007	Date:	2025-11-13
Customer:	Banner Engineering Corp.	Temperature:	20.4°C
Attendees:	None	Relative Humidity:	0.526%
Customer Project:	None	Bar. Pressure (PMSL):	1004 mb
Tested By:	Jeff Alcock	Job Site:	EV01
Power:	24VDC via 110VAC/60Hz	Configuration:	BANN0742-2

TEST PARAMETERS

Run #:	61	Test Distance (m):	0.8	Ant. Height(s) (m):	1 to 4(m)
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COMMENTS

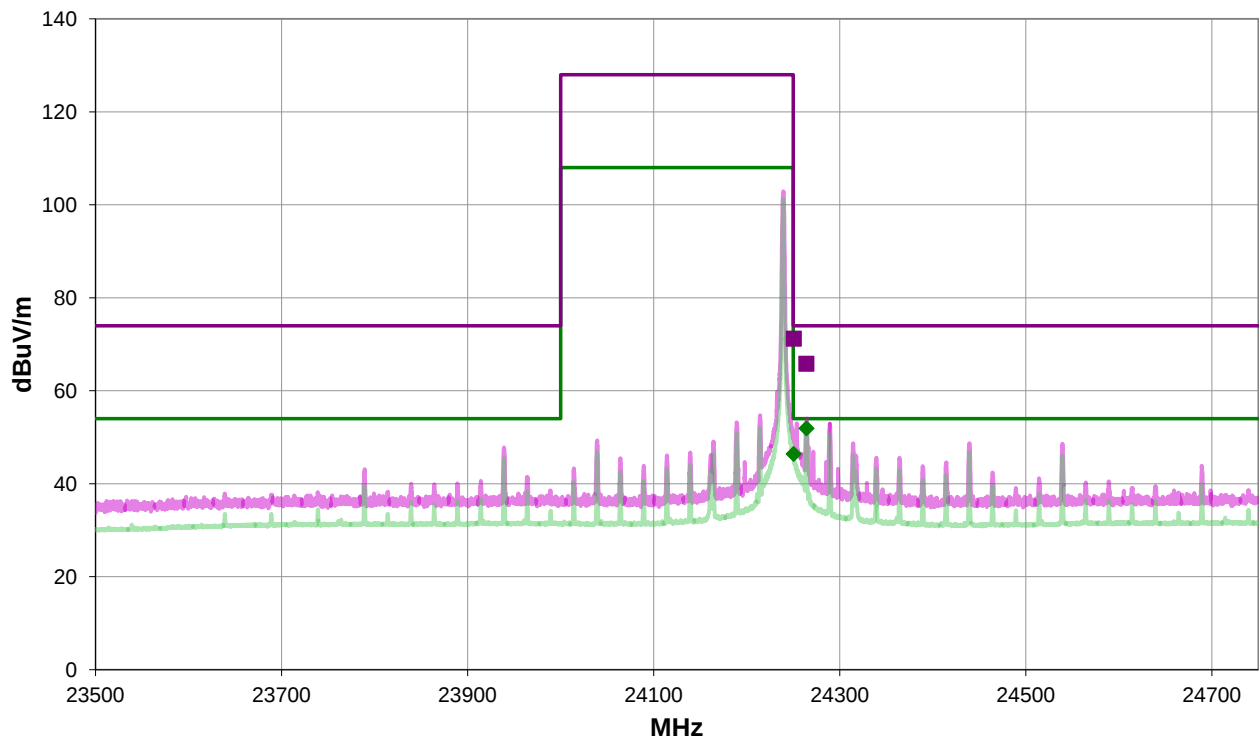
Measurements performed on the EUT's worst case orientation.

EUT OPERATING MODES

CW High = 24.24 GHz

DEVIATIONS FROM TEST STANDARD

None



Run #: 61

PK AV QP

RADIATED BAND EDGE EMISSIONS

RESULTS - Run #61

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)
24264.220	53.2	10.2	1.5	0.0	0.8	0.0	Horz	AV	-11.5	51.9	54.0	-2.1
24250.500	72.5	10.2	1.5	0.0	0.8	0.0	Horz	PK	-11.5	71.2	74.0	-2.8
24250.390	47.7	10.2	1.5	0.0	0.8	0.0	Horz	AV	-11.5	46.4	54.0	-7.6
24264.030	67.1	10.2	1.5	0.0	0.8	0.0	Horz	PK	-11.5	65.8	74.0	-8.2

CONCLUSION

Pass



Tested By

FIELD STRENGTH OF FUNDAMENTAL

TEST DESCRIPTION

The antennas to be used with the EUT were tested. The EUT was transmitting and while set at the lowest channel, a middle channel, and the highest channel available. 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. Worst case orientation is reported.

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

PK = Peak Detector
AV = CISPR Avg. Detector

Measurements performed at distance that is closer than the specified distance were corrected to the specified distance using a 20 dB/decade distance correction factor.

$$\text{Correction factor} = 20 \cdot \log(d_{\text{meas}} / d_{\text{spec}})$$

ANSI C63.10, section 9.1.4: All measurements shall be made in the far-field of the measurement antenna. The far-field boundary for mm-wave antennas is $2D^2 / \lambda$, where D is the largest antenna dimension.

Antenna	D (cm)	freq (GHz)	λ (mm)	Far Field Boundary (cm)	Measurement Distance (cm)	Spec. distance (cm)	Distance Correction Factor (dB)
3160-09	3.87	23.50	12.77	23.5	150	300	-6
	3.87	24.75	12.12	24.7			

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	2024-11-25	2025-11-25
Cable	Micro-Coax	UFD150A-1-0720-200200	EVK	2025-03-21	2026-03-21
Antenna - Standard Gain	ETS Lindgren	3160-09	AIV	2025-01-23	2026-01-23

FREQUENCY RANGE INVESTIGATED

24 GHz TO 24.25 GHz

POWER INVESTIGATED

24VDC via 110VAC/60Hz

CONFIGURATIONS INVESTIGATED

BANN0742-2

MODES INVESTIGATED

CW Low = 24.01 GHz, Mid = 24.13 GHz, High = 24.24 GHz

FIELD STRENGTH OF FUNDAMENTAL

EUT:	MR24 Radar FDS Sensor	Work Order:	BANN0742
Serial Number:	RD2507007	Date:	2025-10-12
Customer:	Banner Engineering Corp.	Temperature:	19.1°C
Attendees:	None	Relative Humidity:	51.4%
Customer Project:	None	Bar. Pressure (PMSL):	1009 mb
Tested By:	Jeff Alcock	Job Site:	EV01
Power:	24VDC via 110VAC/60Hz	Configuration:	BANN0742-2

TEST PARAMETERS

Run #:	50	Test Distance (m):	1.5	Ant. Height(s) (m):	1 to 4(m)
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COMMENTS

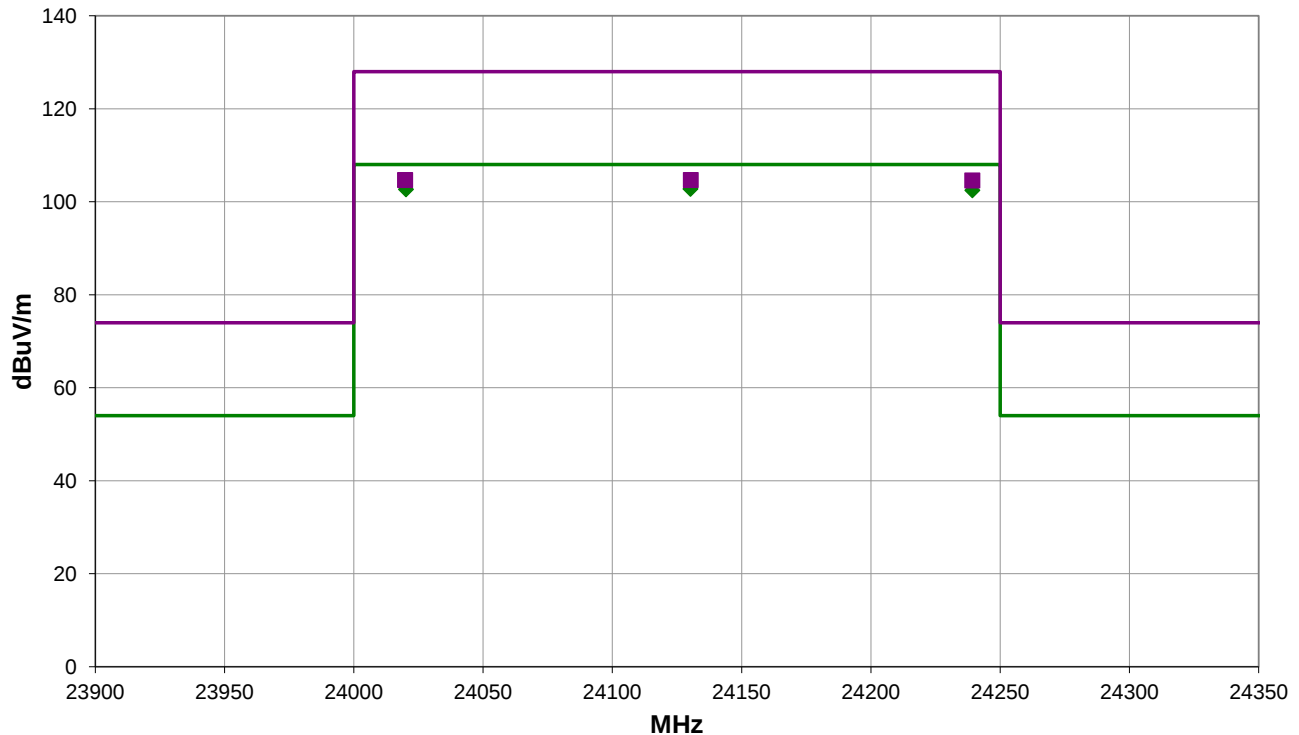
Measurements performed on the EUT's worst case orientation.

EUT OPERATING MODES

CW Low = 24.01 GHz, Mid = 24.13 GHz, High = 24.24 GHz

DEVIATIONS FROM TEST STANDARD

None



Run #: 50

PK AV QP

FIELD STRENGTH OF FUNDAMENTAL

RESULTS - Run #50

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)	Comments
24130.200	65.3	43.5	1.54	10.0	1.5	0.0	Vert	AV	-6.0	102.8	108.0	-5.2	Mid Position - EUT Horz
24020.170	65.3	43.4	1.54	10.0	1.5	0.0	Vert	AV	-6.0	102.7	108.0	-5.3	Low Position - EUT Horz
24239.230	65.0	43.5	1.54	10.0	1.5	0.0	Vert	AV	-6.0	102.5	108.0	-5.5	High Position - EUT Horz
24019.840	67.3	43.4	1.54	10.0	1.5	0.0	Vert	PK	-6.0	104.7	128.0	-23.3	Low Position - EUT Horz
24130.320	67.2	43.5	1.54	10.0	1.5	0.0	Vert	PK	-6.0	104.7	128.0	-23.3	Mid Position - EUT Horz
24239.230	67.1	43.5	1.54	10.0	1.5	0.0	Vert	PK	-6.0	104.6	128.0	-23.4	High Position - EUT Horz

CONCLUSION

Pass



Tested By

EMISSION BANDWIDTH

TEST DESCRIPTION

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

The emission bandwidth was measured with the EUT configured for continuous modulated operation.

Per ANSI C63.10:2020, 6.9.2, the spectrum analyzer was configured as follows:

Sweep time:	20s
Resolution Bandwidth:	1% to 5% of the OBW
Video Bandwidth:	$\geq 3 * RBW$
Detector:	Peak
Trace:	Max Hold
Span:	2 to 5 times the OBW

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

The 20 dB bandwidth shall remain in the designated frequency band

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	2024-11-25	2025-11-25
Antenna - Standard Gain	ETS Lindgren	3160-09	AIV	2025-01-23	2026-01-23
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	EVY	2025-04-27	2026-04-27
Amplifier - Pre-Amplifier	Miteq	AMF-6F-18002650-25-10P	AVU	2025-04-27	2026-04-27

EMISSION BANDWIDTH

EUT:	MR24 Radar FDS Sensor	Work Order:	BANN0742
Serial Number:	RD2507007	Date:	2025-11-20
Customer:	Banner Engineering Corp.	Temperature:	21.2°C
Attendees:	None	Relative Humidity:	42.1%
Customer Project:	None	Bar. Pressure (PMSL):	1019 mbar
Tested By:	Jeff Alcock	Job Site:	EV01
Power:	24VDC via 110VAC/60Hz	Configuration:	BANN0742-1

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

CONCLUSION

Pass

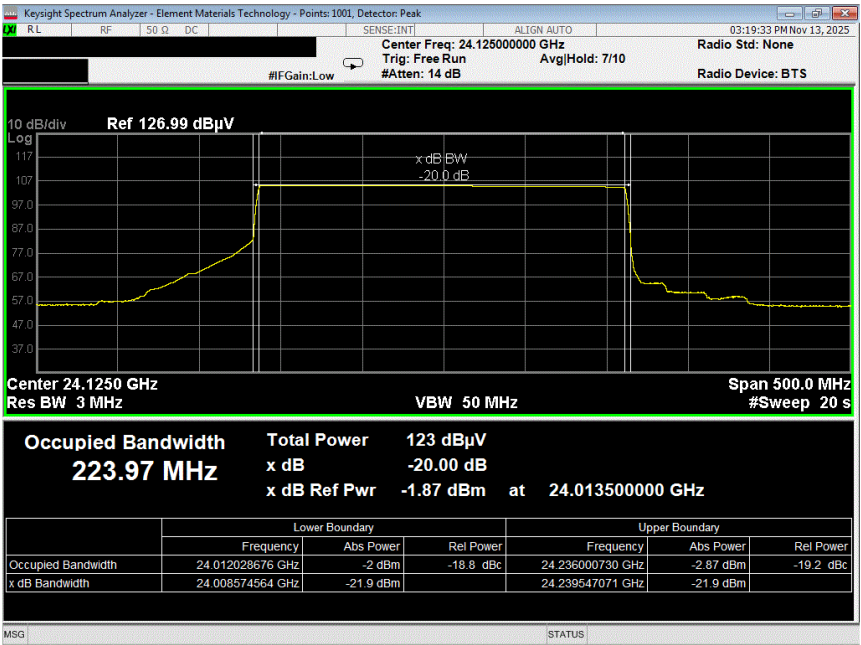


Tested By

TEST RESULTS

	20 dB BW (MHz)	F_low (GHz)	F_High (GHz)	Limit (GHz)	Result
FMCW 24.10 - 24.24 GHz	231	24.009	24.240	$24.00 \leq f \leq 24.25$	Pass

EMISSION BANDWIDTH



FMCW 24.10 - 24.24 GHz

DUTY CYCLE

TEST DESCRIPTION

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 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 radio 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.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFO	2024-11-25	2025-11-25
Antenna - Standard Gain	ETS Lindgren	3160-09	AIV	2025-01-23	2026-01-23
Cable	ESM Cable Corp.	TTBJ141-KMKM-72	EVY	2025-04-27	2026-04-27
Amplifier - Pre-Amplifier	Miteq	AMF-6F-18002650-25-10P	AVU	2025-04-27	2026-04-27

DUTY CYCLE

EUT:	MR24 Radar FDS Sensor	Work Order:	BANN0742
Serial Number:	RD2507007	Date:	2025-11-17
Customer:	Banner Engineering Corp.	Temperature:	21.2°C
Attendees:	None	Relative Humidity:	47%
Customer Project:	None	Bar. Pressure (PMSL):	1013 mbar
Tested By:	Jeff Alcock	Job Site:	EV01
Power:	24VDC via 110VAC/60Hz	Configuration:	BANN0742-1

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

CONCLUSION

N/A

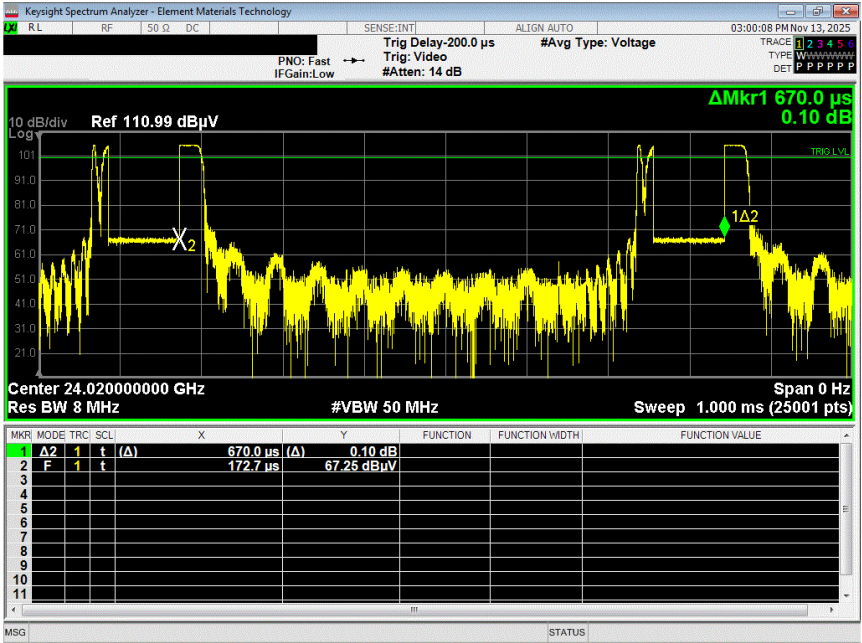


Tested By

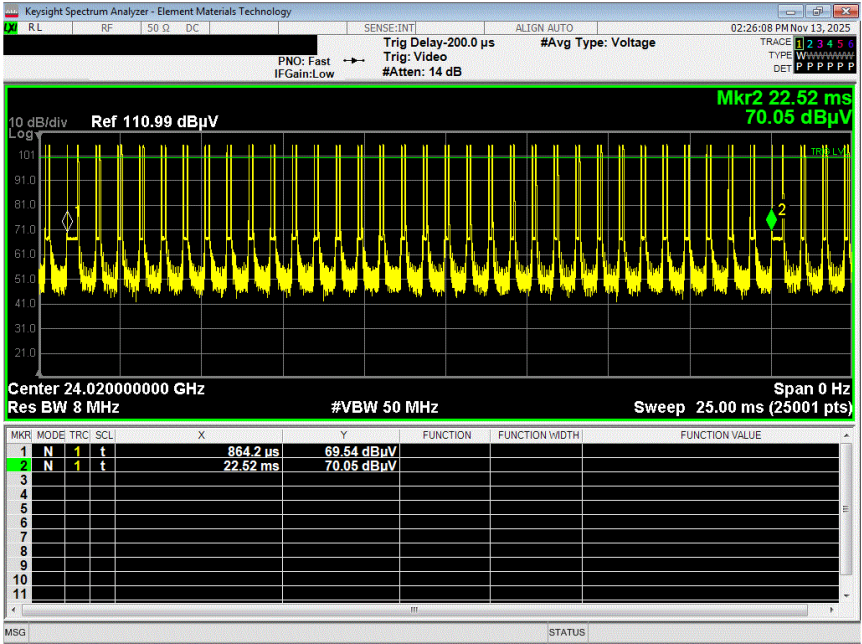
TEST RESULTS

	Duration (μ s)	# Chirps	Total On Time (μ s)	Period (μ s)	Duty Cycle (%)	Limit	Result
FMCW, 24.01-24.24 GHz							
Chirp	670	1	-	-	-	-	-
Frame	22520	32	-	-	-	-	-
Calculation	670	32	21440	22520	95.2	N/A	N/A

DUTY CYCLE



FMCW, 24.01-24.24 GHz
Chirp



FMCW, 24.01-24.24 GHz
Frame

End of Test Report