RADIO REPORT

FCC 47 CFR Part 15F

Ultra Wide Band Devices

Report Reference No	G0M-2403-2508-TFC15FUW-V01
Testing Laboratory	Eurofins Product Service GmbH
Address	Storkower Str. 38c 15526 Reichenwalde Germany
Accreditation	DAkkS - Registration number: D-PL-12092-01-04 (FCC) FCC Filed Test Laboratory, Reg.-No.: 96970
Applicant	Jungheinrich AG
Address	Friedrich-Ebert-Damm 129 22047 Hamburg Germany
Test Specification	47 CFR Part 15F
Non-Standard Test Method	None
Equipment under Test (EUT):	
Product Description	UWB-Location-System is able to measure distances between the UWB components
Model(s)	52445052, Truck Tag
Additional Model(s)	None
Brand Name(s)	zoneCONTROL
Hardware Version(s)	10625 FS:04
Software Version(s)	0.0.51
FCC ID	2AK6M-52445052
Test Result	**PASSED**

Possible test case verdicts:		
Required by standard but not tested	N/T	
Not required by standard	N/R	
Not applicable to EUT	N/A	
Test object does meet the requirement	P(PASS)	
Test object does not meet the requirement	F(FAIL)	
Testing:		
Test Lab Temperature	20 °C - 30 °C	
Test Lab Humidity	25 % - 55 %	
Date of receipt of test item	2024-05-14	
Report:		
Compiled by	Florian Voigt	
Tested by (+ signature)	Md Abu Bakar Siddique	
Approved by (+ signature) (Test Lab Engineer)	Florian Voigt	
Date of Issue	2024-11-26	
Total number of pages	67	
General Remarks:		
The test results presented in this report relate only to the object tested. **The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.** This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.		
Additional Comments:		
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ADDITIONAL VARIANTS

Additional Variants (not tested and not evaluated variants)		
Not-tested Variant	**Description**	
1	Product Type Description	UWB-Location-System is able to measure distances between the UWB components
	Model name	52445053, Truck Tag
	Brand name	zoneCONTROL
	Hardware Version	10625 FS:04
	Software Version	0.0.51
Comment: Those named additional variants above have not been tested. Those additional variants of the series have been declared by the manufacturer. The test report explicitly states that those variants were neither tested nor assessed nor evaluated.		

VERSION HISTORY

Version History			
Version	Issue Date	Remarks	Revised By
01	2024-11-26	Initial Release	

ABBREVIATIONS AND ACRONYMS

Acronyms	
Acronym	Description
EUT	Equipment Under Test
FCC	Federal Communications Commission
RBW	Resolution bandwidth
RFID	Radio Frequency Identification
RMS	Root mean square
VBW	Video bandwidth
V_{NOM}	Nominal supply voltage
f_L	Low edge frequency of UWB (-10) dB bandwidth
f_H	High edge frequency of UWB (-10) dB bandwidth
f_M	UWB frequency with highest peak power in UWB (-10) dB bandwidth measurement
f_C	Centre frequency of UWB (-10) dB bandwidth
B_{-10}	-10 dB bandwidth
μ_{-10}	-10 dB fractional bandwidth

REPORT INDEX

1 Equipment (Test Item) Under Test

Description	UWB-Location-System is able to measure distances between the UWB components	
Model	52445052, Truck Tag	
Additional Model(s)	None	
Brand Name(s)	zoneCONTROL	
Serial Number(s)	51853934	
Test Sample Id(s)	48550	
Hardware Version(s)	10625 FS:04	
Software Version(s)	0.0.51	
FCC ID	2AK6M-52445052	
Equipment class	Hand held (Customer declaration)	
Equipment type	End Product	
Radio type	Transceiver	
Operating frequency range	3.1 – 10.6 GHz	
Radio technology	Ultra Wide-band	
Modulation	BPSK with BPM	
Number of UWB radios	1	
Antenna	Type	Integrated antenna
	Model	PCB Antenna
	Manufacturer	Siemens
	Gain	3.47 dBi @ 4.0 GHz 5.65 dBi @ 6.5 GHz
Supply Voltage	V_{NOM}	24 VDC
Operating Temperature	T_{NOM}	25 °C
AC/DC-Adaptor	None	
Manufacturer	Siemens Aktiengesellschaft R&D House CHE DI PA DCP R&D 5 Rochlitzer Str. 19 09111 Chemnitz Germany	

1.4 Support Equipment

Product Type	Device	Manufacturer	Model	Comment
AE	Laptop	HP	ProBook	For setting test modes
AE	USB-Serial-Adapter	Agilon	Not specified	--
AE	JH-Tester	Siemens	Tag Mobile	Test hardware to attach the EUTs CAN
CBL	Cable	Siemens	Not specified	From PCB with COM port to EUT
CBL	Connection Cord	Siemens	Not specified	Link between Tester and EUT
CBL	USB Cable	A-B Cable	Not specified	--
SFT	RadioMode Setup Tool v3.1.0	Siemens	Not specified	For setting test modes
Description:				
AE	Auxiliary Equipment			
SIM	Simulator			
CBL	Connecting Cable			
SFT	Software			
Comment: --				

1.5 Test Modes

Mode	Description
Transmit	Mode = Transmit Modulation = BPSK with BPM Duty cycle = 100% Power setting = -6 dB (set by the software provided by customer)
Comment: --	

1.6 Test Frequencies

Designator	Mode	Channel	Frequency [MHz]
F1	Tx	2	3993.6
F2	Tx	5	6489.6

1.7 Sample emission level calculation

The following is a description of terms and a sample calculation, as appears in the radiated emissions data table. The numbers used in the calculation are for example only. There is no direct correlation to the specific data taken for the product described in this document:

Reading:

This is the reading obtained on the spectrum analyzer in dBµV. Any external preamplifiers used are taken into account through internal analyzer settings.

A.F.:

This is the antenna factor for the receiving antenna. It is a conversion factor, which converts electric fields strengths to voltages, which can be measured directly on the spectrum analyzer. It is treated as a loss in dB. Cable losses have been included with the A.F. to simplify the calculations. The antenna factor is used in calculations as follows:

Reading on Analyzer (dBµV) + A.F. (dB/m) = Net field strength (dBµV/m)

Net:

This is the net field strength measurement (as shown above).

Margin:

This is the margin of compliance below the FCC limit. The units are given in dB. A negative margin indicates the emission was below the limit. A positive margin indicates that the emission exceeds the limit.

Field strength limit:

This is the FCC Class B radiated emission limit (in units of dBµV/m). The FCC limits are given in units of µV/m. The following formula is used to convert the units of µV/m to dBµV/m:

Field strength limit (dBµV/m) = 20 · log (µV/m)

Example only for radiated field strength:

Reading + AF	= Net Reading	:	Net reading	- Field strength limit	= Margin
+21.5 dBµV	+ 26 dB/m	:	47.5 dBµV/m	- 57.0 dBµV/m	= -9.5

2 Result Summary

FCC 47 CFR Part 15F				
Product Standard Reference	**Requirement**	**Reference Method**	**Result**	**Remarks**
FCC 15.503(a), 15.519(b)	UWB (-10 dB) Bandwidth	ANSI C63.10-2013	PASS	--
FCC 15.519(e)	Peak power	ANSI C63.10-2013	PASS	--
FCC 15.519(a)(1)	Cease of transmitter operation	ANSI C63.10-2013	PASS	--
FCC 15.519(c)(d)	Transmitter radiated emissions	ANSI C63.10-2013	PASS	--
FCC 15.207	AC power line conducted emissions	ANSI C63.10-2013	N/R	Note 1
Note 1: EUT is not connected directly or indirectly via AC-Mains				
Comment: The Decision Rule is applied on the basis of ETSI TR 102 273 and ETSI TR 100 028. These standards provide guidance on how to calculate and apply measurement uncertainty whilst providing maximum uncertainties allowance. In all cases due consideration will be given to ILAC-G8:09/2019. Where a result is considered conditional in respect of its proximity to the limit line, the customer would be made aware of situation so that they can make an informed decision on how to proceed.				

Possible Test Case Verdicts	
PASS	Test object does meet the requirements
FAIL	Test object does not meet the requirements
N/T	Required by standard but not tested
N/R	Not required by standard for the test object

3 Test Conditions and Results

3.1 Test Conditions and Results - UWB (-10 dB) Bandwidth

3.1.1 Information

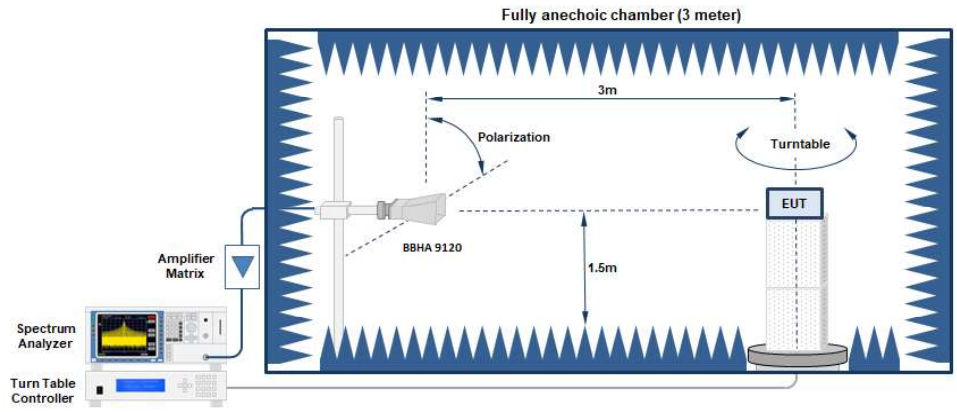
Test Information	
Product Standard Reference	FCC Part 15.519 (a)
Measurement Method	ANSI C63.10 10.1
Measurement Uncertainty	± 1.26 %
Date	2024-06-19 to 2024-06-26
Operator	Md Abu Bakar Siddique

3.1.2 Limits

Limits
UWB (-10 dB) bandwidth totally contained in the band 3.1 - 10.6 GHz additionally UWB (-10 dB) bandwidth ≥ 500 MHz or fractional bandwidth ≥ 0.20

3.1.3 Setup

Test Setup



3.1.4 Equipment

Test Software			
Description	Manufacturer	Name	Version
EMC Software	DARE Instruments	RadiMation	2020.1.8
EMC Software	DARE Instruments	RadiMation	2023.2.6

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF00062	2022-11	2025-11
Test Receiver	Rohde & Schwarz	ESW44	EF01856	2024-04	2025-04
Antenna	Schwarzbeck	BBHA 9120D	EF01561	2021-11	2024-11
Anechoic Chamber	Frankonia	AC2	EF01616	2023-12	2024-12
Spectrum analyzer	R&S	FSW43	EF00896	2023-08	2024-08
Antenna	Schwarzbeck	BBHA 9120B	EF01678	2024-05	2027-05

3.1.5 Procedure

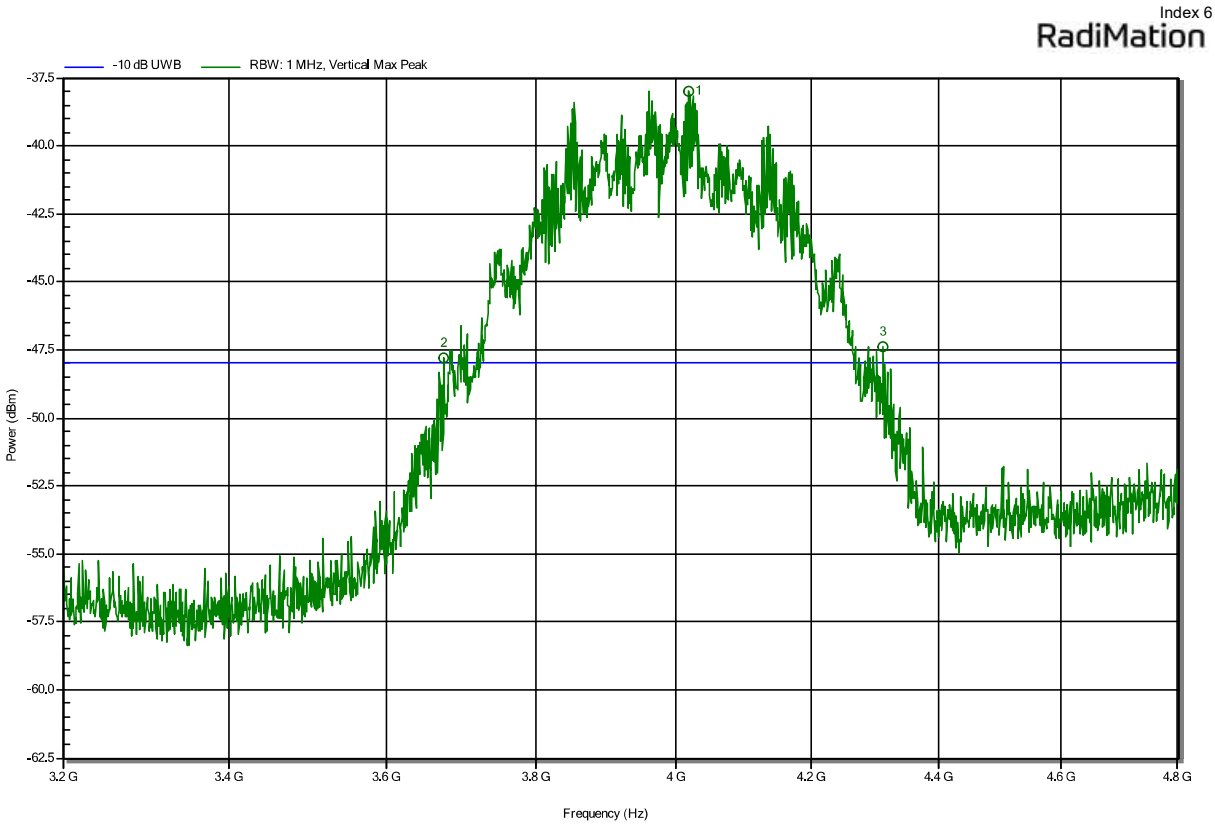
Test Procedure
1. EUT set to test mode 2. The turntable and antenna polarization are set to the maximum emission level for the fundamental emission of the EUT 3. Span is set so that the complete fundamental emission spectrum is captured 3. Resolution bandwidth set to 1 MHz and the VBW is set to 3 MHz with peak detector and max. hold 4. The emission spectrum is corrected by the antenna gain cable loss, low-noise amplifier gain 5. The maximum of the spectrum envelope is determined as reference 6. The spectrum is searched from the left edge to the center of the spectrum in order to find the lower -10 dB frequency 7. The spectrum is searched from the right edge to the center of the spectrum in order to find the upper -10 dB frequency 8. From the lower and upper frequency the center frequency, the -10 dB bandwidth and the fractional bandwidth are calculated

3.1.6 Results

Test Results - Antenna 1 (UWB1)							
Channel [MHz]	f_M [MHz]	f_C [MHz]	B_{-10} [MHz]	f_L [MHz]	f_H [MHz]	μ_{-10} [MHz]	Verdict
3993.6	4017.6	3993.52	636.4266	3675.3067	4311.7333	0.1593	PASS
6489.6	6631.3667	6507.7	583.6134	6215.8933	6799.5067	0.0896	PASS

UWB (-10 dB) Bandwidth according to 47 CFR Part 15.519

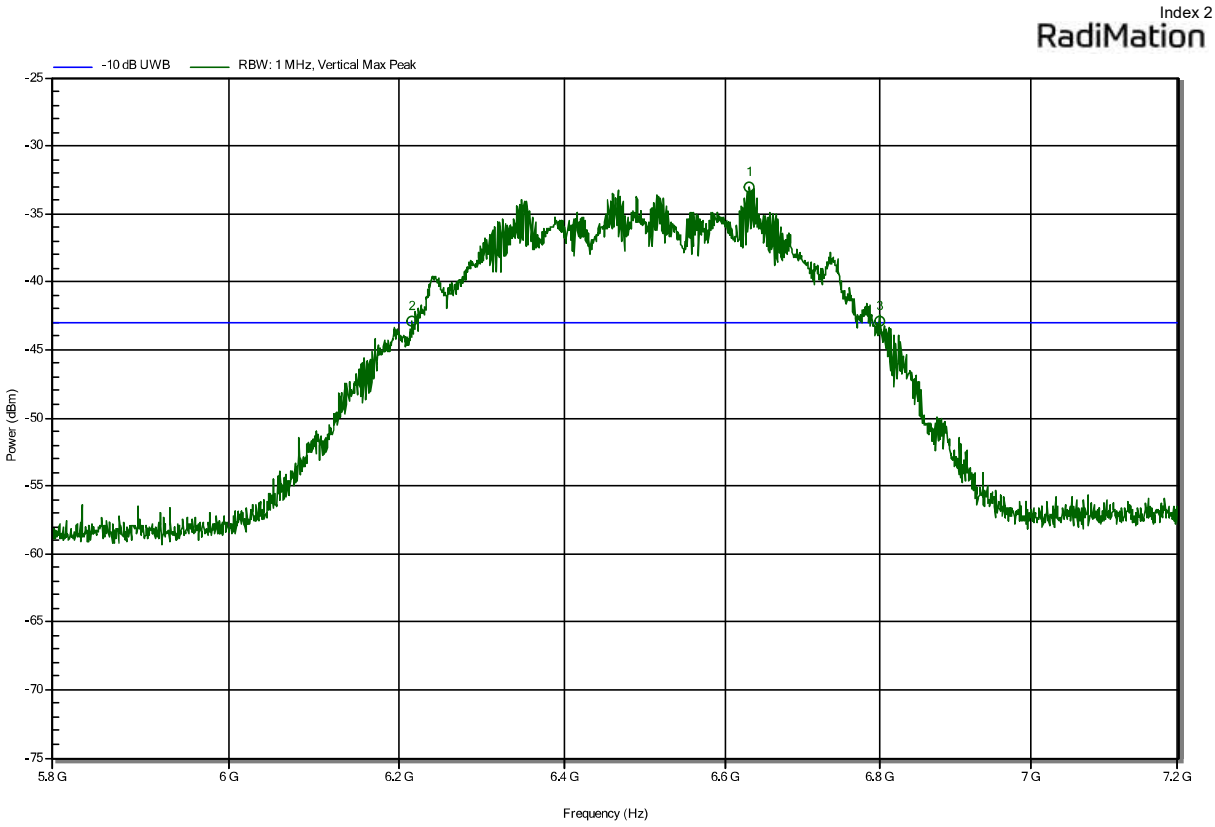
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-26



Peak Number	Frequency (MHz)	Peak (dBm)	Peak (dBm)	Limit	Peak Difference (dB)	Peak Status	Polarization
1	4017.6	-38	-48		10	--	Vertical
2	3675.3067	-47.8	-48		0.23	--	Vertical
3	4311.7333	-47.4	-48		0.62	--	Vertical

UWB (-10 dB) Bandwidth according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120B
Measurement distance:	3 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-19



Peak Number	Frequency (MHz)	Peak (dBm)	Peak (dBm)	Limit	Peak Difference (dB)	Peak Status	Polarization
1	6631.3667	-33	-43		10	--	Vertical
2	6215.8933	-42.9	-43		0.12	--	Vertical
3	6799.5067	-42.9	-43		0.1	--	Vertical

3.2 Test Conditions and Results - Maximum Peak Power

3.2.1 Information

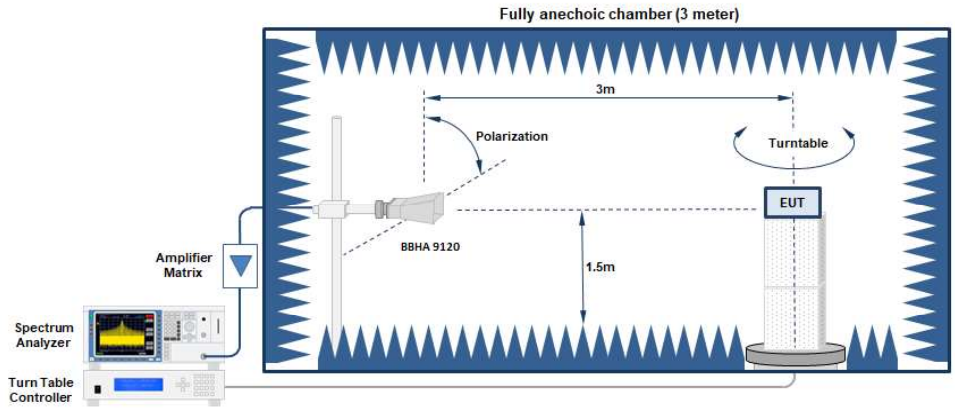
Test Information	
Product Standard Reference	FCC Part 15.519 (e)
Date	2024-06-19 to 2024-06-26
Operator	Md Abu Bakar Siddique
Measurement Method	ANSI C63.10 10.3.5, 10.3.6, 10.3.9
Measurement Uncertainty	± 4.21 dB

3.2.2 Limits

Limits	
Bandwidth [MHz]	Power [dBm EIRP]
50	0

3.2.3 Setup

Test Setup



3.2.4 Equipment

Test Software			
Description	Manufacturer	Name	Version
EMC Software	DARE Instruments	RadiMation	2020.1.8
EMC Software	DARE Instruments	RadiMation	2023.2.6

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF00062	2022-11	2025-11
Test Receiver	Rohde & Schwarz	ESW44	EF01856	2024-04	2025-04
Antenna	Schwarzbeck	BBHA 9120D	EF01561	2021-11	2024-11
Anechoic Chamber	Frankonia	AC2	EF01616	2023-12	2024-12
Spectrum analyzer	R&S	FSW43	EF00896	2023-08	2024-08
Antenna	Schwarzbeck	BBHA 9120B	EF01678	2024-05	2027-05

3.2.5 Procedure

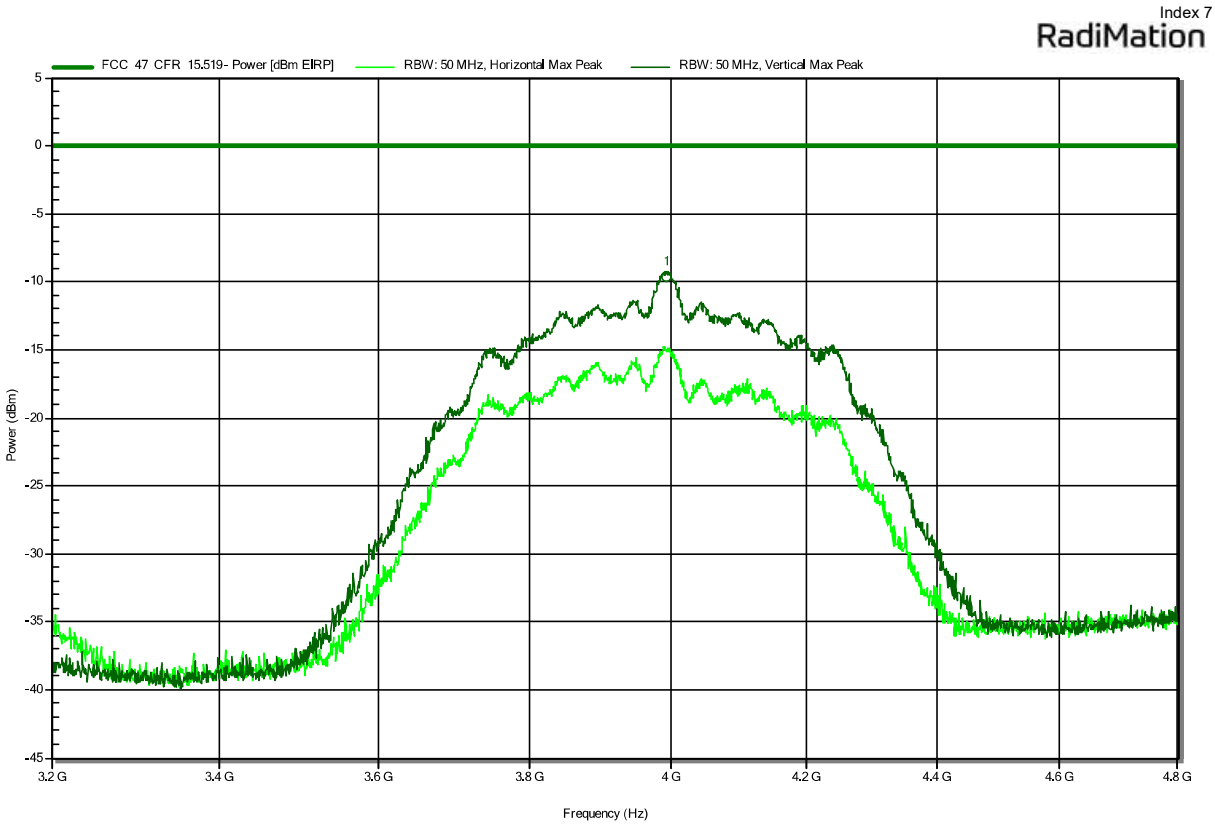
Test Procedure
1. EUT set to test mode 2. The turntable and antenna polarization are set to the maximum emission level for the fundamental emission of the EUT 3. Span is set so that the complete fundamental emission spectrum is captured 3. Resolution bandwidth set to 50 MHz and the VBW is set to maximum with peak detector and max. hold 4. The emission spectrum is corrected by the antenna gain cable loss, low-noise amplifier gain and path loss 5. The maximum of the spectrum envelope is determined and compared to the limit

3.2.6 Results

Test Results				
Channel [MHz]	Emission [MHz]	Power [dBm EIRP]	Limit [dBm EIRP]	Margin [dB]
3993.6	3993.33	-9.7	0	-9.7
6489.6	6483.01	-5.4	0	-5.4

Radiated Spurious Emissions according to 47 CFR Part 15.519

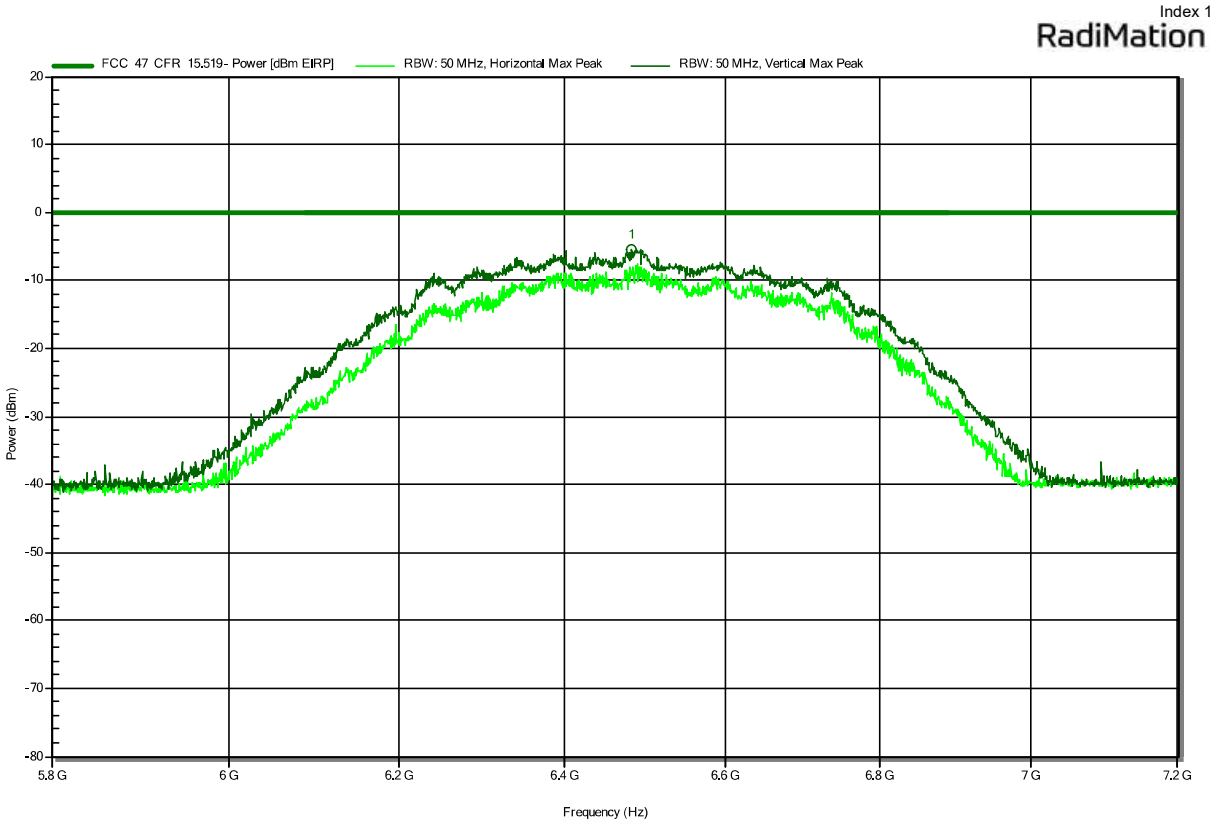
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-26



Peak Number	Frequency (MHz)	Peak (dBm)	Peak (dBm)	Limit	Peak Difference (dB)	Peak Status	Polarization
1	3993.3333	-9.7	0		-9.7	Pass	Vertical

Radiated Spurious Emissions according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120B
Measurement distance:	3 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-19



Peak Number	Frequency (MHz)	Peak (dBm)	Peak (dBm)	Limit	Peak Difference (dB)	Peak Status	Polarization
1	6483.0133	-5.4	0		-5.4	Pass	Vertical

3.3 Test Conditions and Results - Cease of transmitter operation

3.3.1 Information

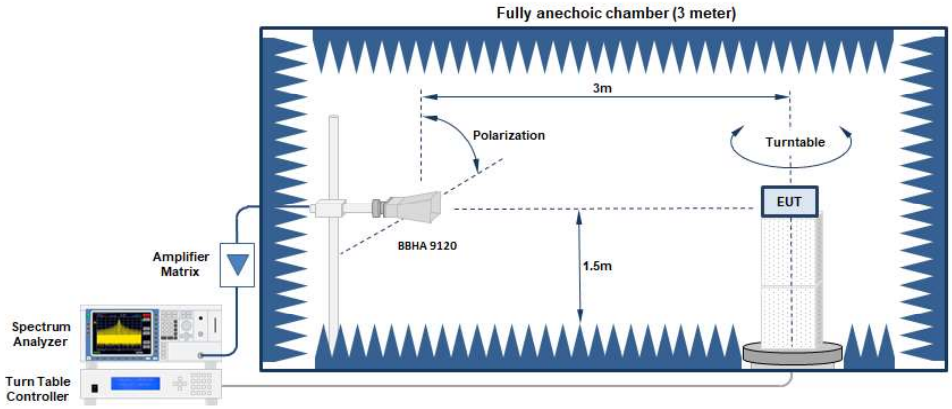
Test Information	
Product Standard Reference	FCC Part 15.519 (a)(1)
Date	2024-08-02
Operator	Md Abu Bakar Siddique

3.3.2 Limits

Limits - FCC
A UWB device shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

3.3.3 Setup

Test Setup



3.3.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic chamber	Frankonia	AC 4	EF00200	--	--
Spectrum Analyzer	R&S	FSU 26	EF01407	2023-08	2024-08
Antenna	Schwarzbeck	BBHA 9120D	EF00019	2023-12	2026-12

3.3.5 Procedure

Test Procedure
1. EUT set to normal operation 2. The emissions of the EUT are captured with a spectrum analyzer 3. The transmitter is stopped either by switching off the companion device or by releasing the manual switch 4. From the moment the transmitter is released the emission are recorded and a marker is set to the moment the transmitter has switched off 5. The marker time is recorded and compared to the limit

3.3.6 Results

Test Results			
Channel [MHz]	Transmission stop time [s]	Limit [s]	Margin [s]
4000	7.372	10	-2.628

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
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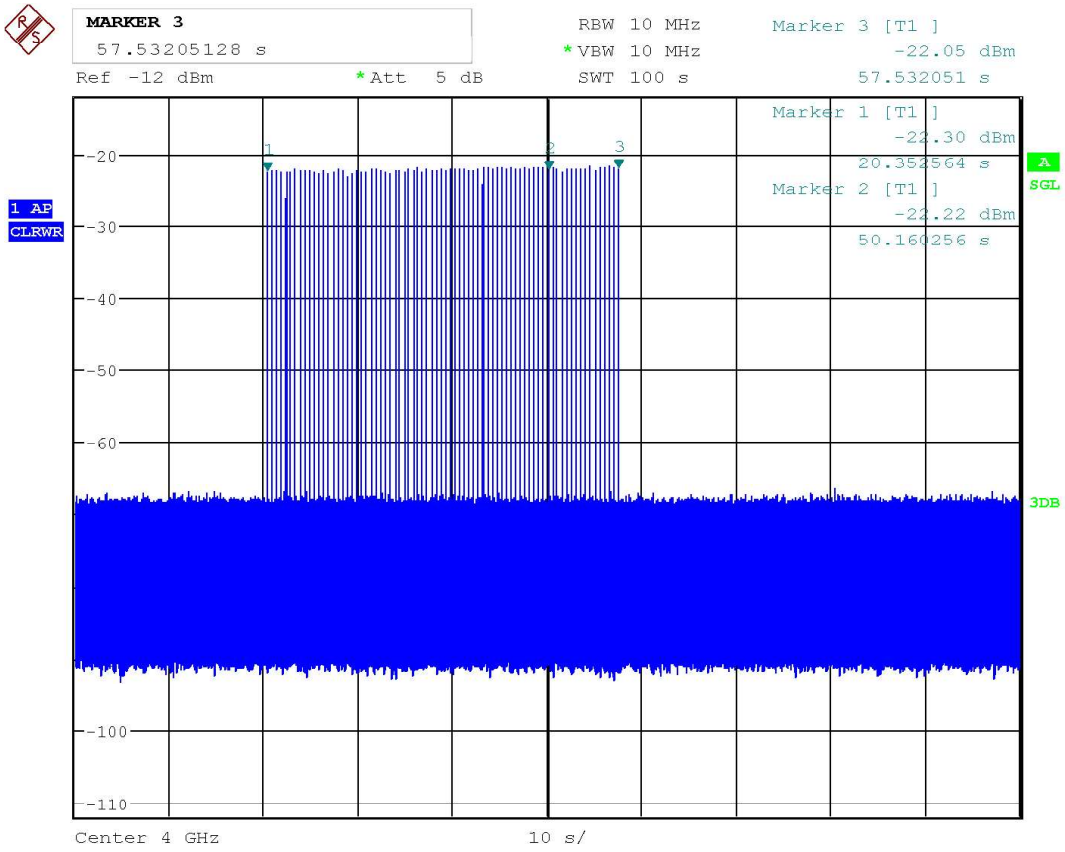
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Test Date:	2024-08-02



Date: 2.AUG.2024 12:54:07

Marker Number	Time(s)	Comment
1	20.352	Start of communication between EUT and companion device
2	50.160	Companion device was turned off
3	57.532	Cease of transmit from EUT

3.4 Test Conditions and Results - Transmitter radiated emissions

3.4.1 Information

Test Information	
Product Standard Reference	FCC Part 15.519 (c)(d)
Measurement Method	ANSI C63.10 10.2, 10.3
Measurement Uncertainty	± 5.95 dB
Date	2024-06-21 to 2024-08-02
Operator	Md Abu Bakar Siddique
Comment: Some non-ultrawideband emissions generated by digital circuits have been found. This emissions do not comply with the requirements defined in § 15.519(c). However this emission do comply with the requirements defined in § 15.209(a) as permissible by § 15.521(c). Detailed evaluation of this issues is listed in ANNEX B.	

3.4.2 Limits

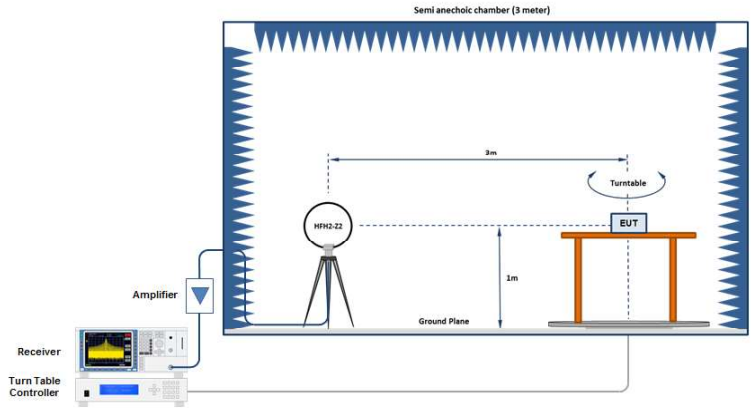
Limits - below 960 MHz			
Frequency [MHz]	Detector	Field strength [µV/m]	Measurement distance [m]
0.009 - 0.09	Average	2400/F[kHz]	300
0.09 - 0.110	Quasi-Peak	2400/F[kHz]	300
0.110 - 0.490	Average	2400/F[kHz]	300
0.490 - 1.705	Quasi-Peak	24000/F[kHz]	30
1.705 - 30.0	Quasi-Peak	30	30
30 - 88	Quasi-Peak	100	3
88 - 216	Quasi-Peak	150	3
216 - 960	Quasi-Peak	200	3

Limits - FCC - above 960 MHz					
Frequency [MHz]	Bandwidth	Detector	Power [dBm EIRP]	Field Strength [dBµV/m@3m]	Field Strength [dBµV/m@1m]
960-1610	1 MHz	RMS	-75.3	19.9	29.5
1610-1990	1 MHz	RMS	-63.3	31.9	41.5
1990-3100	1 MHz	RMS	-61.3	33.9	43.5
3100-10600	1 MHz	RMS	-41.3	53.9	63.5
> 10600	1 MHz	RMS	-61.3	33.9	43.5

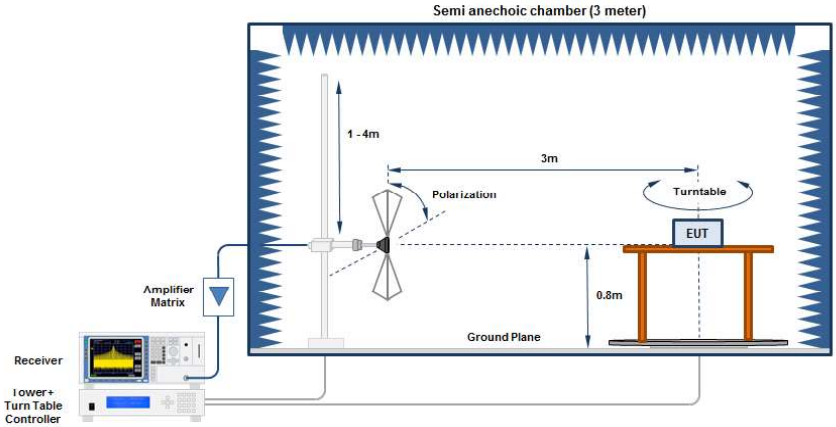
Limits - GPS Band					
Frequency [MHz]	Bandwidth	Detector	Power [dBm EIRP]	Field Strength [dBµV/m@3m]	Field Strength [dBµV/m@1m]
1164-1240	1 kHz	RMS	-85.3	9.9	19.5
1559-1610	1 kHz	RMS	-85.3	9.9	19.5

3.4.3 Setup

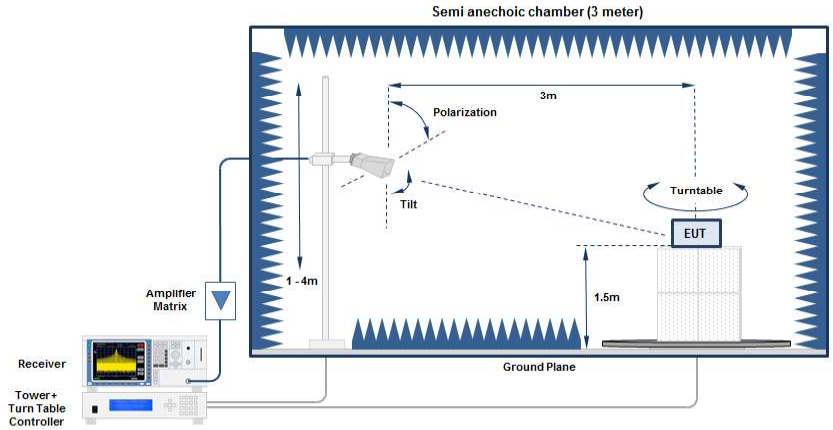
Test Setup – f < 30 MHz



Test Setup – f < 960 MHz



Test Setup – f > 960 MHz



3.4.4 Equipment

Test Software			
Description	Manufacturer	Name	Version
EMC Software	DARE Instruments	RadiMation	2020.1.8
EMC Software	DARE Instruments	RadiMation	2023.2.6

Test Equipment f < 30 MHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF00062	--	--
Loop Antenna	R&S	HFH2-Z2	EF00184	2024-02	2027-02
Test Receiver	R&S	ESW44	EF01856	2024-04	2025-04

Test Equipment 30 - 960 MHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF00062	2022-11	2025-11
Antenna	Schwarzbeck	VULB 9168	EF01824	2022-10	2025-10
Test Receiver	R&S	ESW44	EF01856	2024-04	2025-04

Test Equipment 0.96 – 4.8 GHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF01011	2023-11	2024-11
Antenna	Schwarzbeck	BBHA 9120D	EF01561	2021-11	2024-11
Test Receiver	R&S	ESW44	EF01856	2024-04	2025-04

Test Equipment f > 4.8 GHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic chamber	Frankonia	AC 2	EF01616	2023-12	2024-12
Spectrum analyzer	R&S	FSW43	EF00896	2023-08	2024-08
Horn antenna	Schwarzbeck	BBHA 9120B (1-10GHz)	EF01678	2024-05	2027-05
Douple Ridged Waveguide Horn Antenna	Schwarzbeck	HWRD 650 (6,5-18GHz)	EF01679	2024-05	2027-05
Antenna	Amplifier Research	AT4560	EF00302	2023-09	2025-09
Antenna	Flann Microwave Ltd	22240-25 Amp. CBL26402075	EF00301	2023-01	2026-01

3.4.5 Procedure

Test Procedure f < 30 MHz
1. EUT is placed on a non conducting support at the center of a turn table 0.8 m above the ground 2. EUT set to test mode 3. The receiver is set to peak and average detection with max hold 4. The EUT is rotated through 360° 5. All significant emissions are measured again using the corresponding final detector

Test Procedure 30 - 960 MHz
1. EUT is placed on a non conducting support at the center of a turn table 0.8 m above the ground 2. EUT set to test mode 3. The receiver is set to peak detection with max hold 4. The EUT is rotated through 360° and the height of the antenna is varied from 1 m to 4 m 5. All significant emissions are measured again using the corresponding final detector

Test Procedure 960 - 4800 MHz
1. EUT is placed on a non conducting support at the center of a turn table 1.5 m above the ground 2. EUT set to test mode 3. The receiver is set to RMS detection with max hold, measure time is set to 1 ms, step size is set to RBW/2. 4. The EUT is rotated through 360° and the height of the antenna is varied from 1 m to 4 m

Test Procedure > 4800 MHz
1. EUT is placed on a non conducting support at the center of a turn table 1.5 m above the ground 2. EUT set to test mode 3. The receiver is set to RMS detection with max hold, 30001 sweep points and 30 s sweep time. 4. The EUT is rotated through 360° and the height of the antenna is varied from 1 m to 4 m

3.4.6 Results

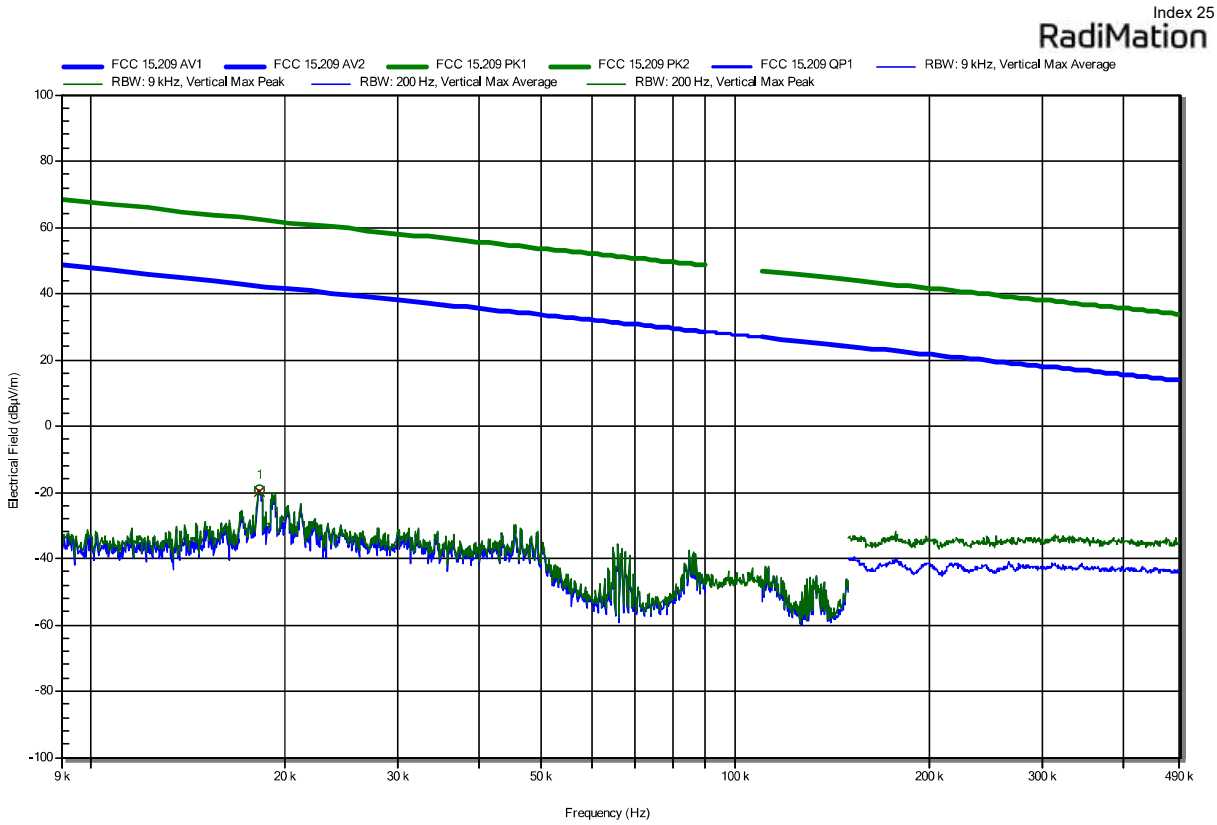
Test Results – below 960 MHz						
Channel [MHz]	Emission [MHz]	Level [dBµV/m]	Det.	Pol.	Limit [dBµV/m]	Margin [dB]
3993.6	0.018	-19.3	pk	Ver	62.3	-81.64
3993.6	0.018	-19.8	avg	ver	42.3	-62.19
3993.6	0.018	-14.9	pk	ver	62.4	-77.24
3993.6	0.018	-16.3	avg	ver	42.4	-58.68
3993.6	0.52	3.3	pk	ver	33.3	-30.01
3993.6	64.72	26.7	pk	ver	40	-13.32
3993.6	153.69	26	pk	hor	43.5	-17.52
3993.6	350.85	30.2	pk	ver	46	-15.81
3993.6	787.02	37	pk	hor	46	-9.02
6489.6	0.019	-19.1	pk	ver	62	-81.06
6489.6	0.019	-19.6	avg	ver	42	-61.59
6489.6	0.52	1.8	pk	ver	33.3	-31.46
6489.6	0.018	-16.9	pk	ver	62.4	-79.27
6489.6	0.018	-17.1	avg	ver	42.4	-59.47
6489.6	780.82	36.1	pk	ver	46	-9.89
6489.6	352.4	30.6	pk	ver	46	-15.37
6489.6	62.24	25.5	pk	hor	40	-14.54
6489.6	263.43	26.3	pk	hor	46	-19.7

Test Results – above 960 MHz						
Channel [MHz]	Emission [MHz]	Level [dBm]	Det.	Pol.	Limit [dBm]	Margin [dB]
3993.6	1360.4373	-63.4	RMS	hor	-75.3	11.9*
3993.6	1606.1087	-75.1	RMS	hor	-85.3	10.21*
3993.6	3993.6	-47.6	RMS	ver	-41.3	-6.33
3993.6	7987.312	-53.2	RMS	ver	-41.3	-11.89
3993.6	39897.85	-67.5	RMS	ver	-61.3	-6.2
6489.6	1376.5	-63.8	RMS	ver	-75.3	11.46*
6489.6	1008	-74.1	RMS	hor	-75.3	1.16*
6489.6	1607.705	-80.9	RMS	hor	-85.3	4.4*
6489.6	6489.6	-41.9	RMS	ver	-41.3	-0.64
6489.6	12979.0975	-65	RMS	ver	-61.3	-3.68
6489.6	17893.3333	-65.1	RMS	ver	-61.3	-3.81
6489.6	26001.333	-83.2	RMS	ver	-61.3	-21.89
6489.6	39899.65	-67.6	RMS	ver	-61.3	-6.31
Note *: Emission is above the ultra wide band limit but is not an ultra wide band emission. See Annex B for further evaluation.						

ANNEX A Transmitter radiated emissions

Radiated Spurious Emissions according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Rohde & Schwarz HFH 2-Z2, Vertical
Measurement distance:	3 m, converted to 300 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-26
Note:	Antenna parallel to EUT PCB

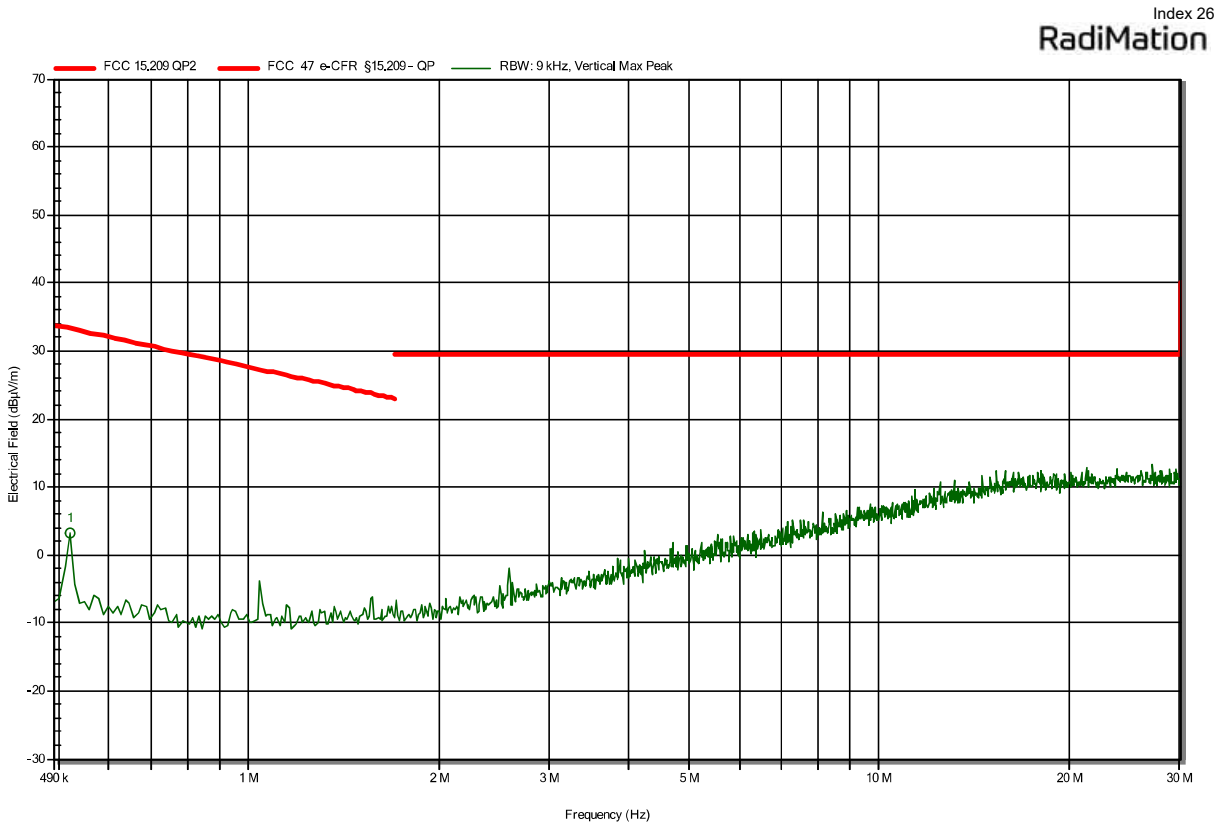


Peak Number	Frequency (MHz)	Peak (dBµV/m)	Peak (dBµV/m)	Limit	Peak (dB)	Difference	Peak Status
1	0.018	-19.3	62.3		-81.64		Pass

Peak Number	Frequency (MHz)	Average (dBµV/m)	Average (dBµV/m)	Limit	Average (dB)	Difference	Average Status
1	0.018	-19.8	42.3		-62.19		Pass

Radiated Spurious Emissions according to 47 CFR Part 15.519

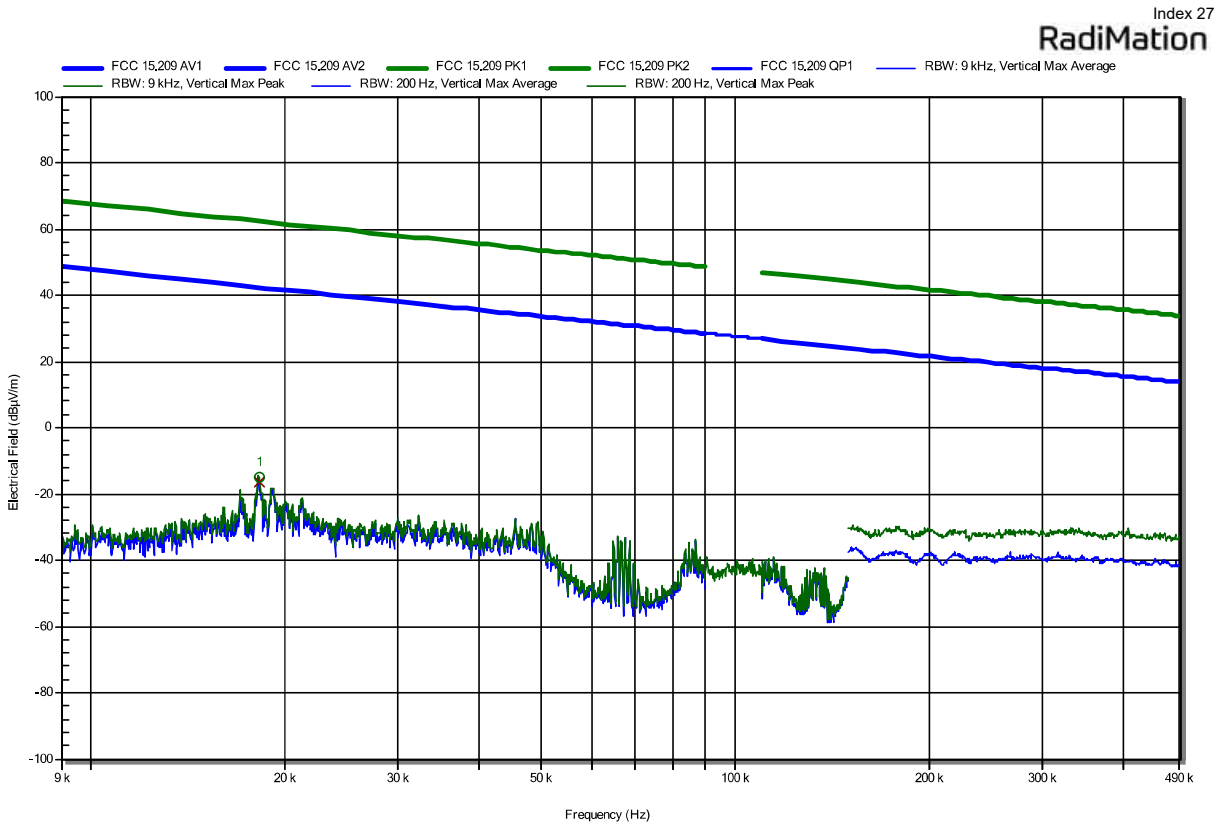
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Rohde & Schwarz HFH 2-Z2, Vertical
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-26
Note:	Antenna parallel to EUT PCB



Peak Number	Frequency (MHz)	Peak (dBµV/m)	Peak (dBµV/m)	Limit	Peak (dB)	Difference	Peak Status
1	0.52	3.3	33.3		-30.01		Pass

Radiated Spurious Emissions according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Rohde & Schwarz HFH 2-Z2, Vertical
Measurement distance:	3 m, converted to 300 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-26
Note:	Antenna perpendicular to EUT PCB

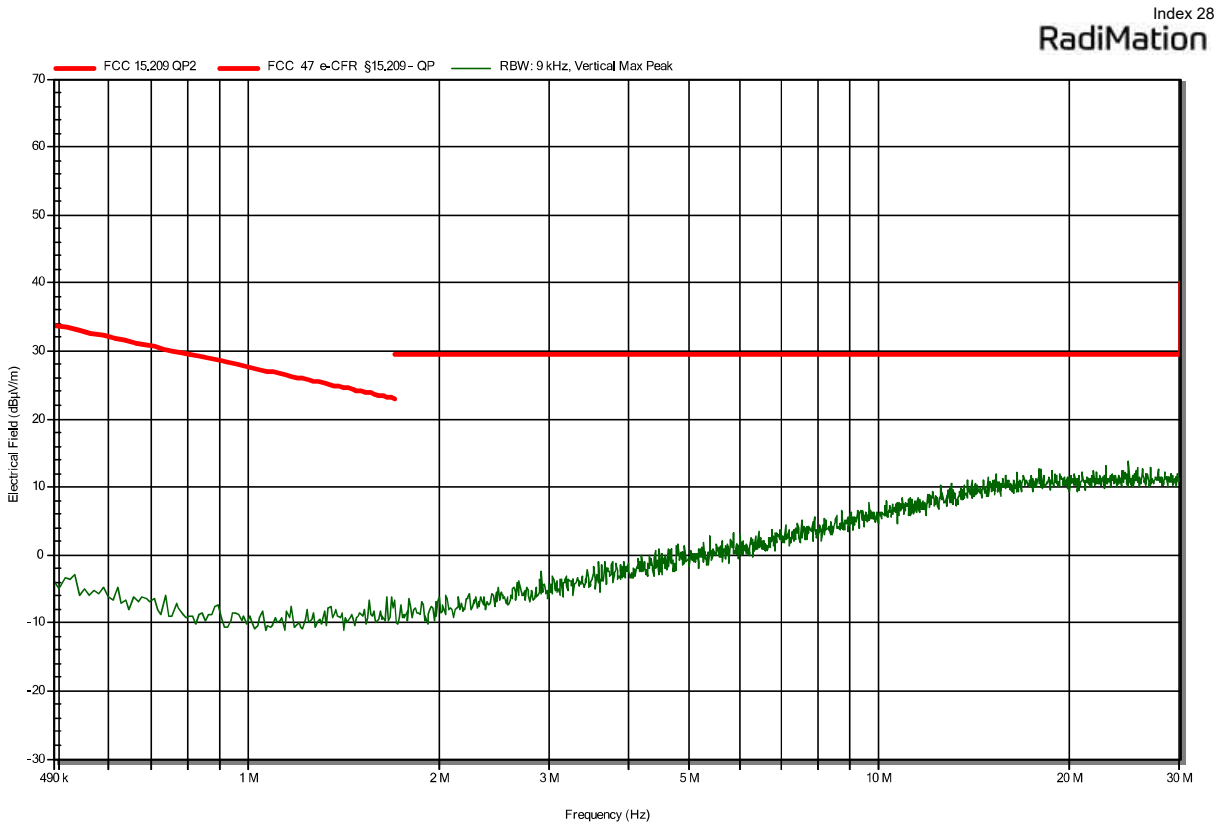


Peak Number	Frequency (MHz)	Peak (dBµV/m)	Peak (dBµV/m)	Limit	Peak (dB)	Difference	Peak Status
1	0.018	-14.9	62.4		-77.24		Pass

Peak Number	Frequency (MHz)	Average (dBµV/m)	Average (dBµV/m)	Limit	Average (dB)	Difference	Average Status
1	0.018	-16.3	42.4		-58.68		Pass

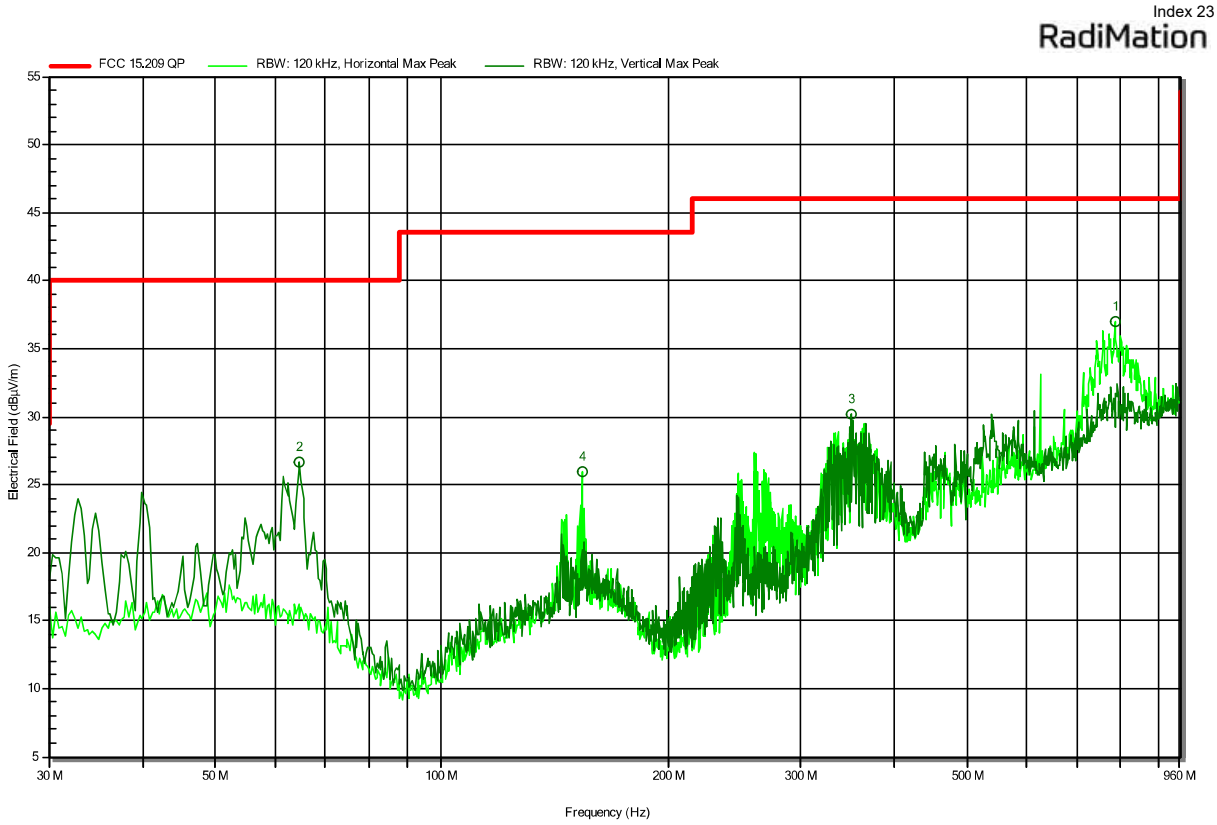
Radiated Spurious Emissions according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Rohde & Schwarz HFH 2-Z2, Vertical
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-26
Note:	Antenna perpendicular to EUT PCB



Radiated Spurious Emissions according to 47 CFR Part 15.519

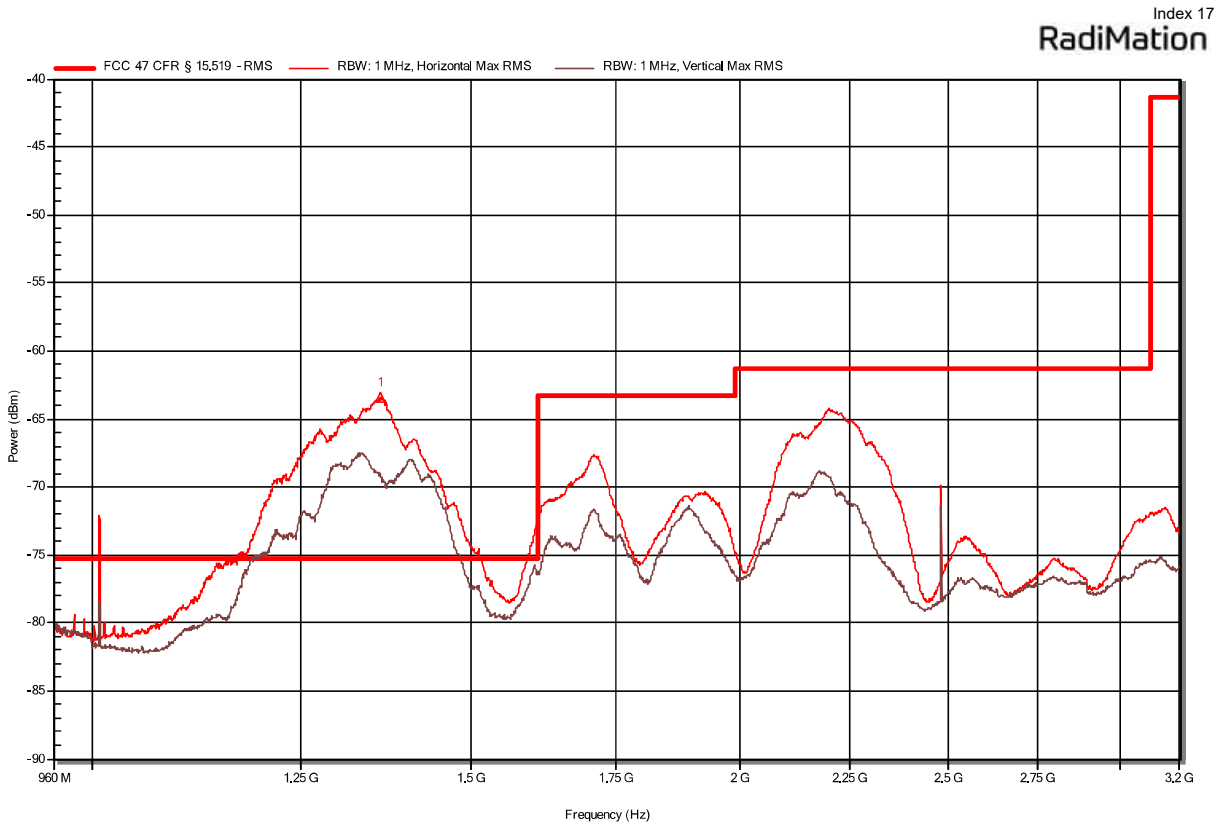
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck VULB 9168
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-25



Peak Number	Frequency (MHz)	Peak (dBµV/m)	Peak (dBµV/m)	Limit	Peak Difference (dB)	Peak Status	Polarization
1	787.02	37	46		-9.02	Pass	Horizontal
2	64.72	26.7	40		-13.32	Pass	Vertical
3	350.85	30.2	46		-15.81	Pass	Vertical
4	153.69	26	43.5		-17.52	Pass	Horizontal

Radiated Spurious Emissions according to 47 CFR Part 15.519

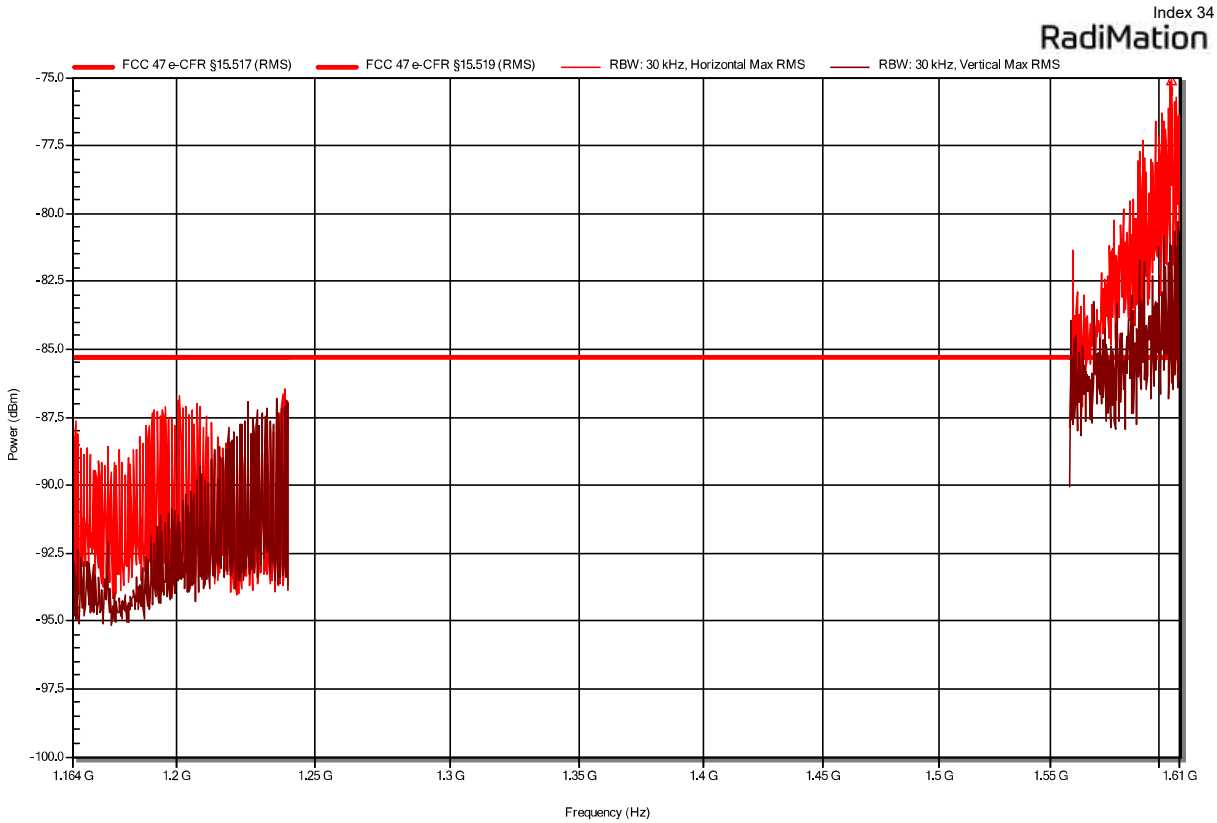
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-22
Note:	Non UWB emissions below 2 GHz on plot, see ANNEX B



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS (dB)	Difference	RMS Status	Polarization
1	1360.4373	-63.4	-75.3		11.9		See ANNEX B	Horizontal

Radiated Spurious Emissions according to 47 CFR Part 15.519

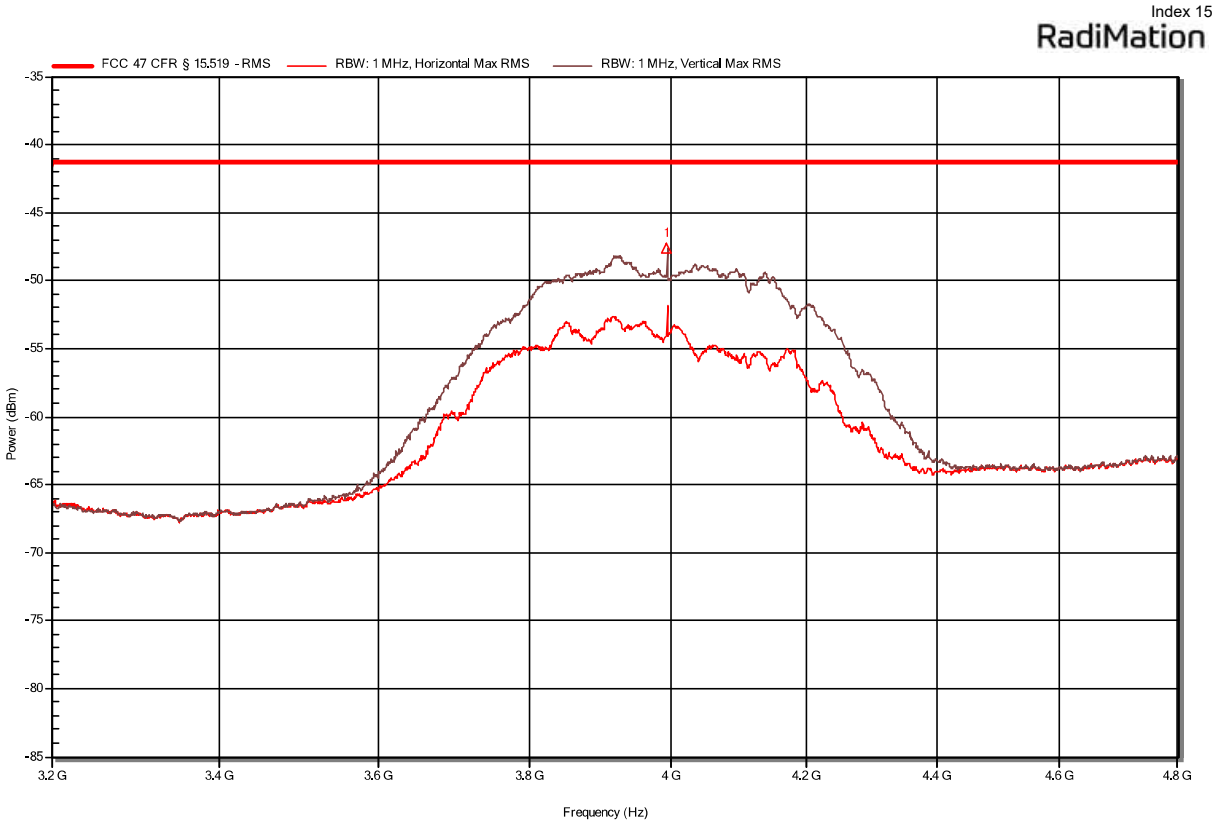
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 23 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	1.5 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-29
Note:	Non UWB emissions on plot, see ANNEX B, page 63 and page 65 for evaluation



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS Difference (dB)	RMS Status	Polarization
1	1606.1087	-75.1	-85.3		10.21	See ANNEX B	Horizontal

Radiated Spurious Emissions according to 47 CFR Part 15.519

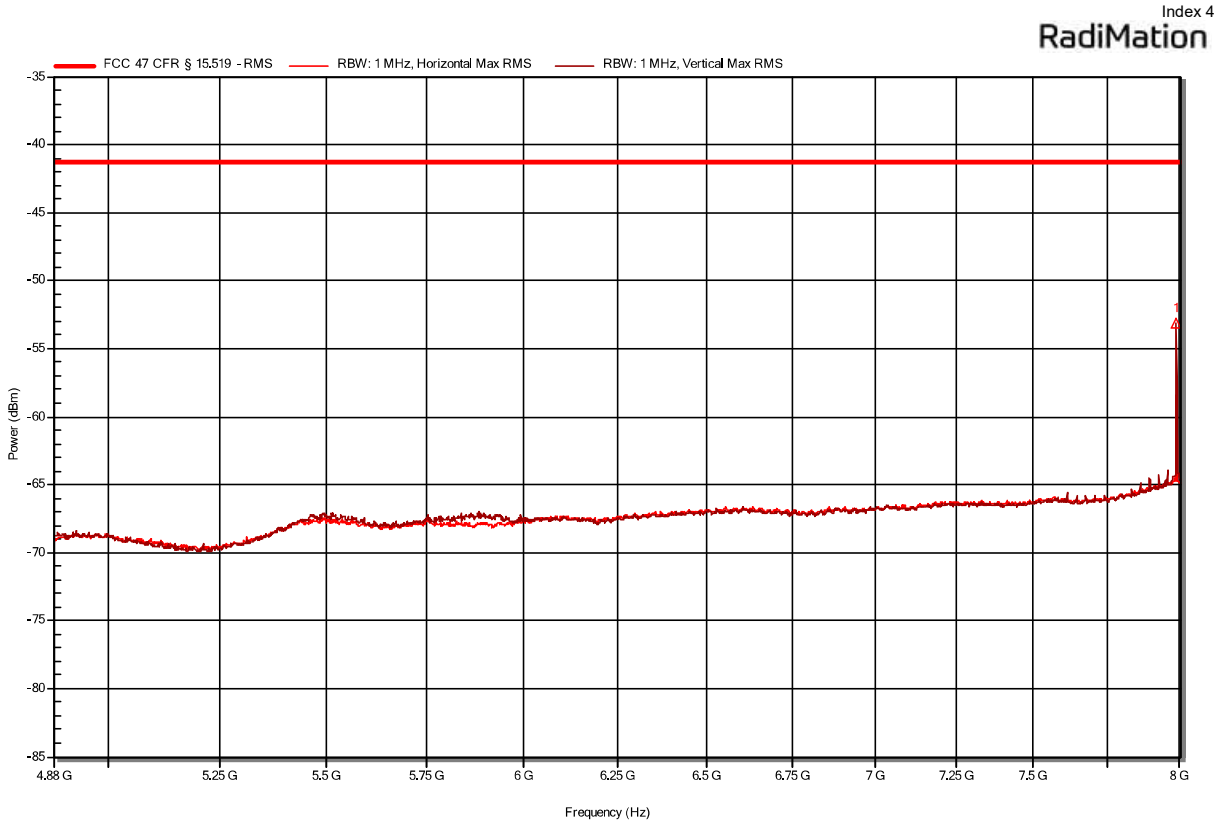
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-22



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS (dB)	Difference	RMS Status	Polarization
1	3993.6	-47.6	-41.3		-6.33		Pass	Vertical

Radiated Spurious Emissions according to 47 CFR Part 15.519

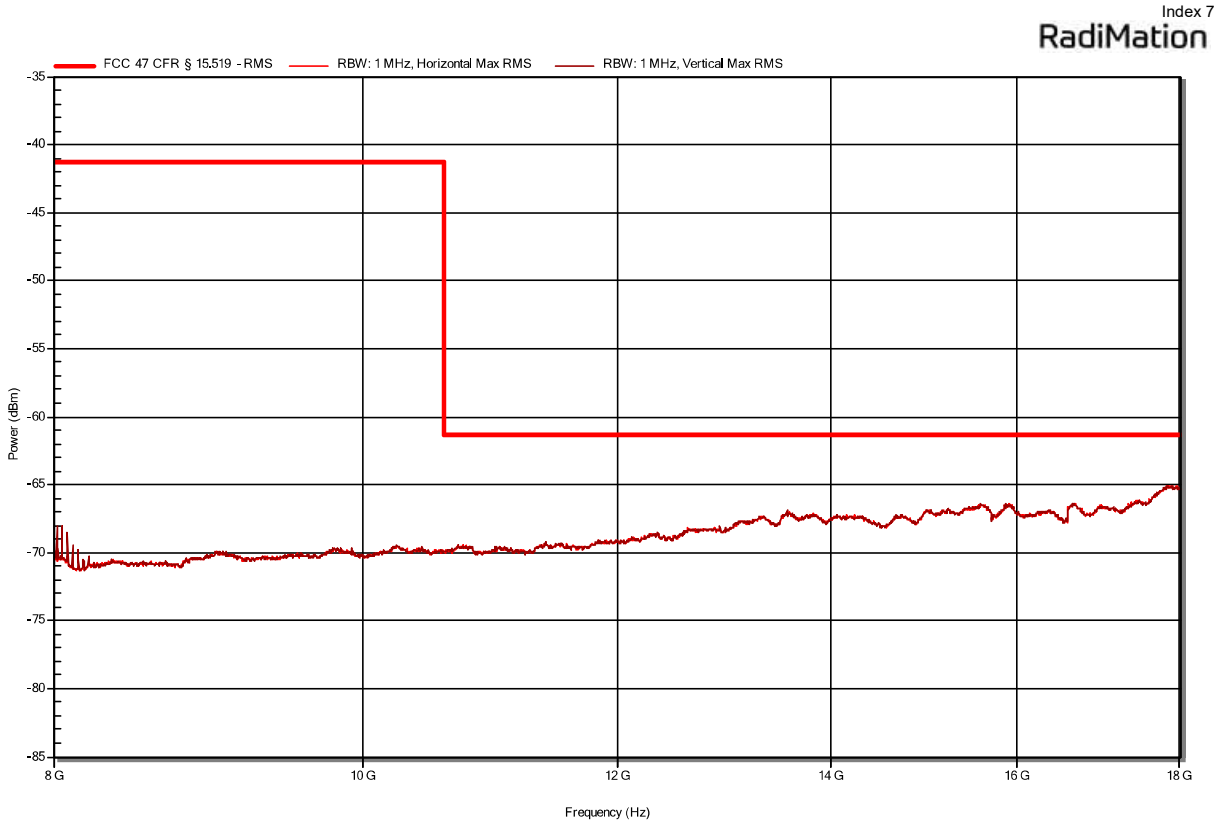
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120B
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-20



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS Difference (dB)	RMS Status	Polarization
1	7987.312	-53.2	-41.3		-11.89	Pass	Vertical

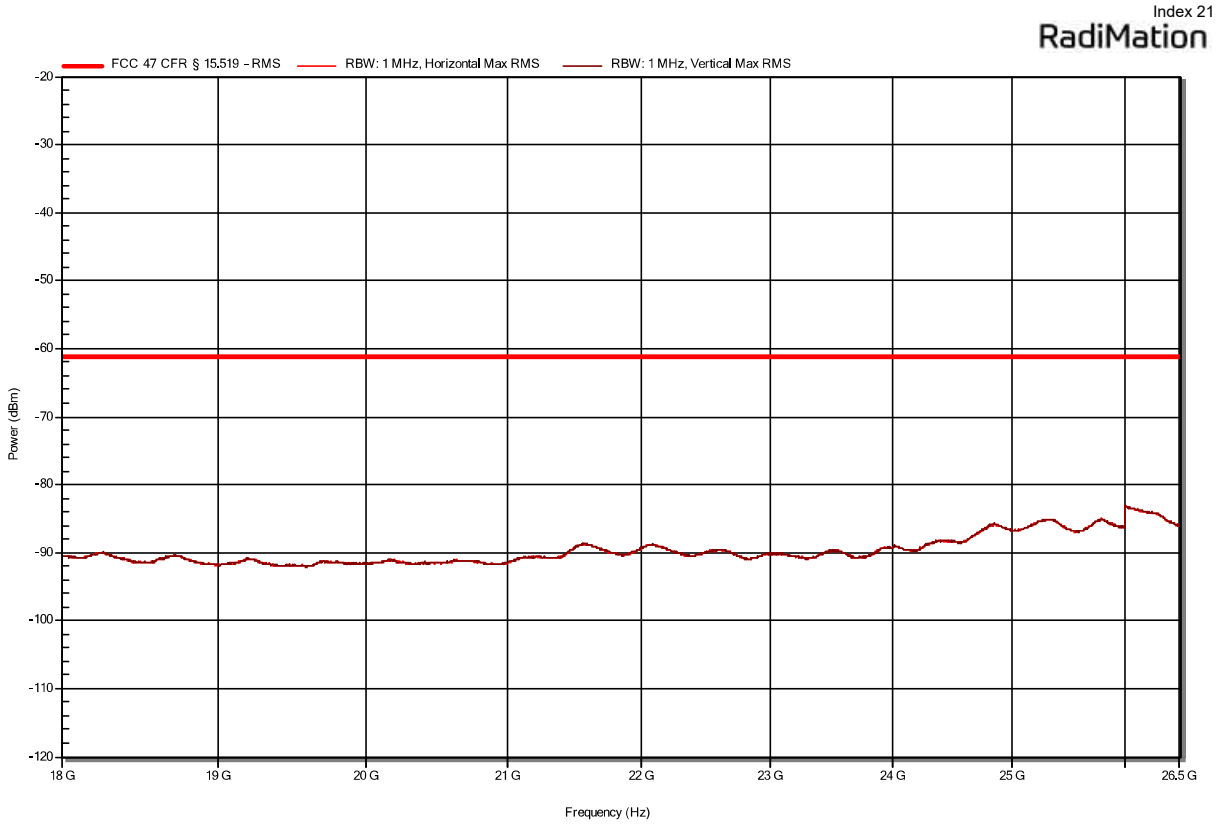
Radiated Spurious Emissions according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck HWRD 650
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-20



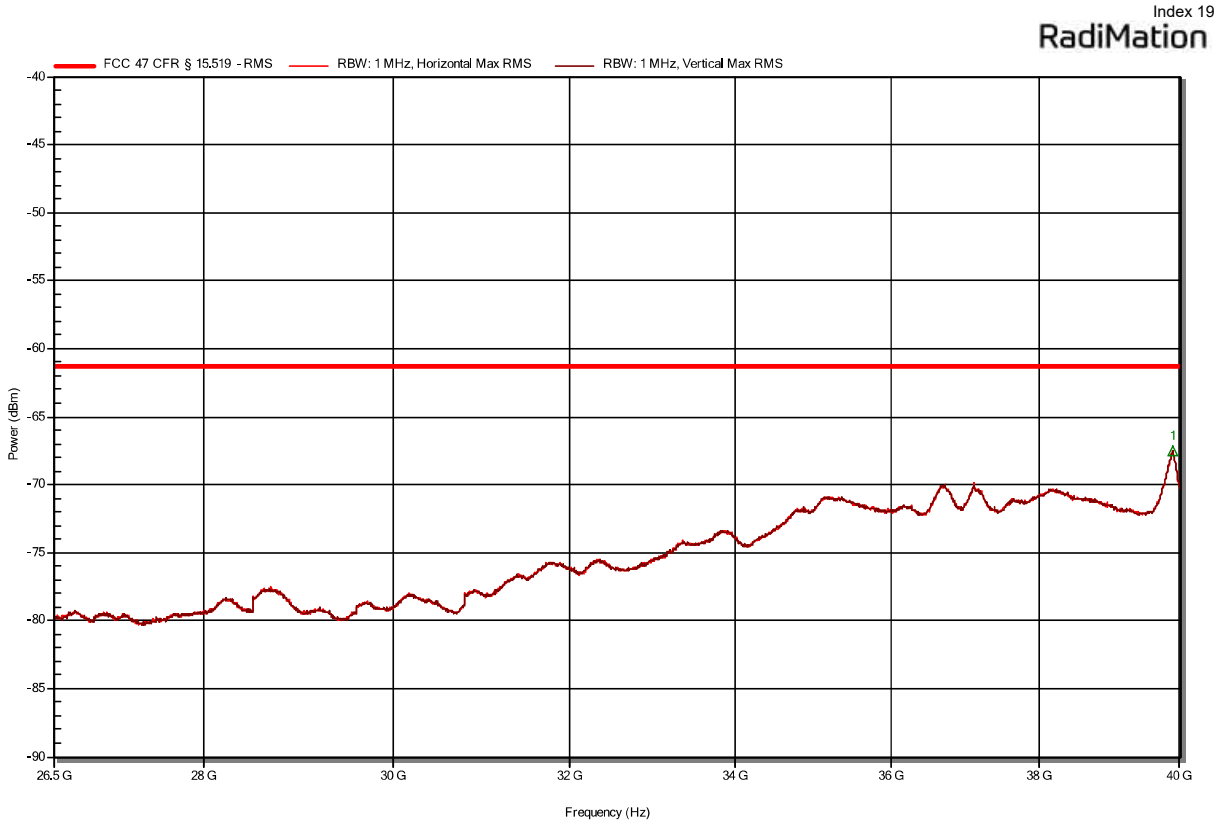
Radiated Spurious Emissions according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Amplifier Research AT4560
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-24



Radiated Spurious Emissions according to 47 CFR Part 15.519

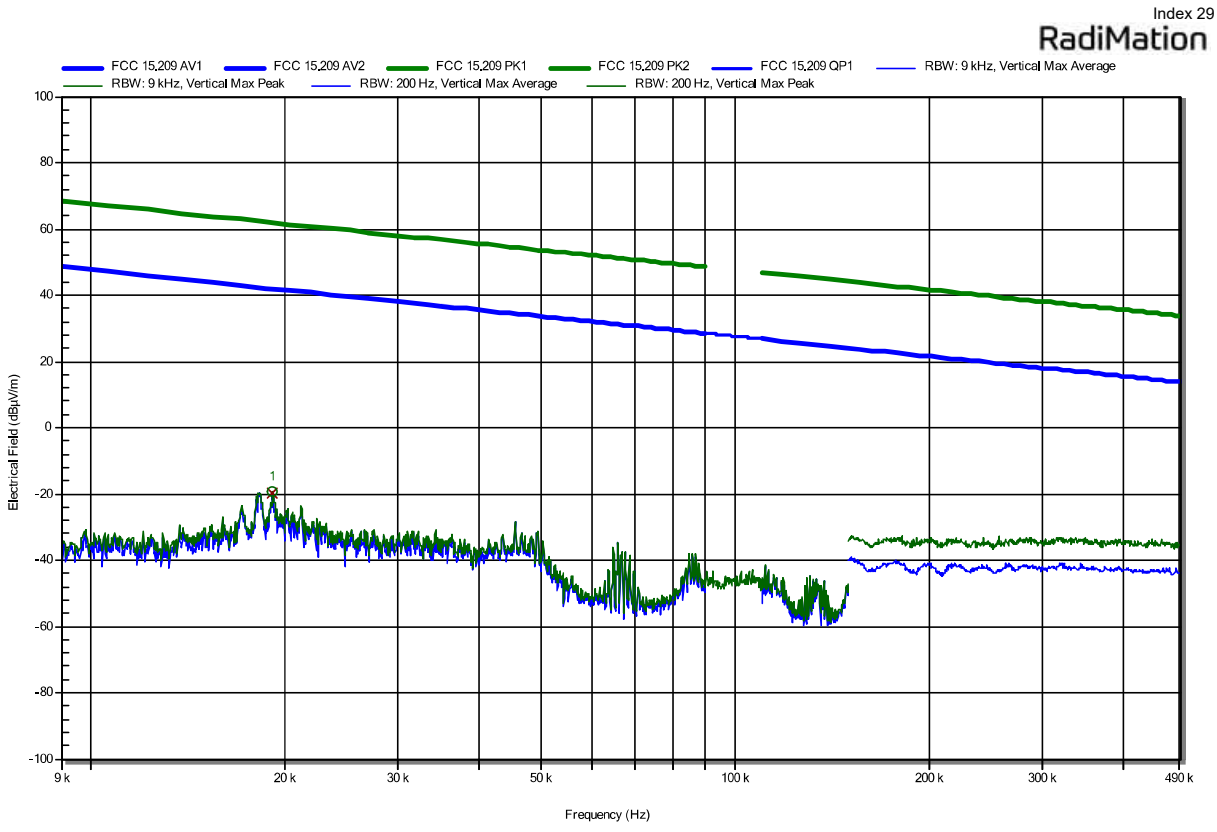
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Flann 22240-25
Measurement distance:	1 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB
Test Date:	2024-06-24



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS (dB)	Difference	RMS Status	Polarization
1	39897.85	-67.5	-61.3		-6.2		Pass	Vertical

Radiated Spurious Emissions according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Rohde & Schwarz HFH 2-Z2, Vertical
Measurement distance:	3 m, converted to 300 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-26
Note:	Antenna parallel to EUT PCB

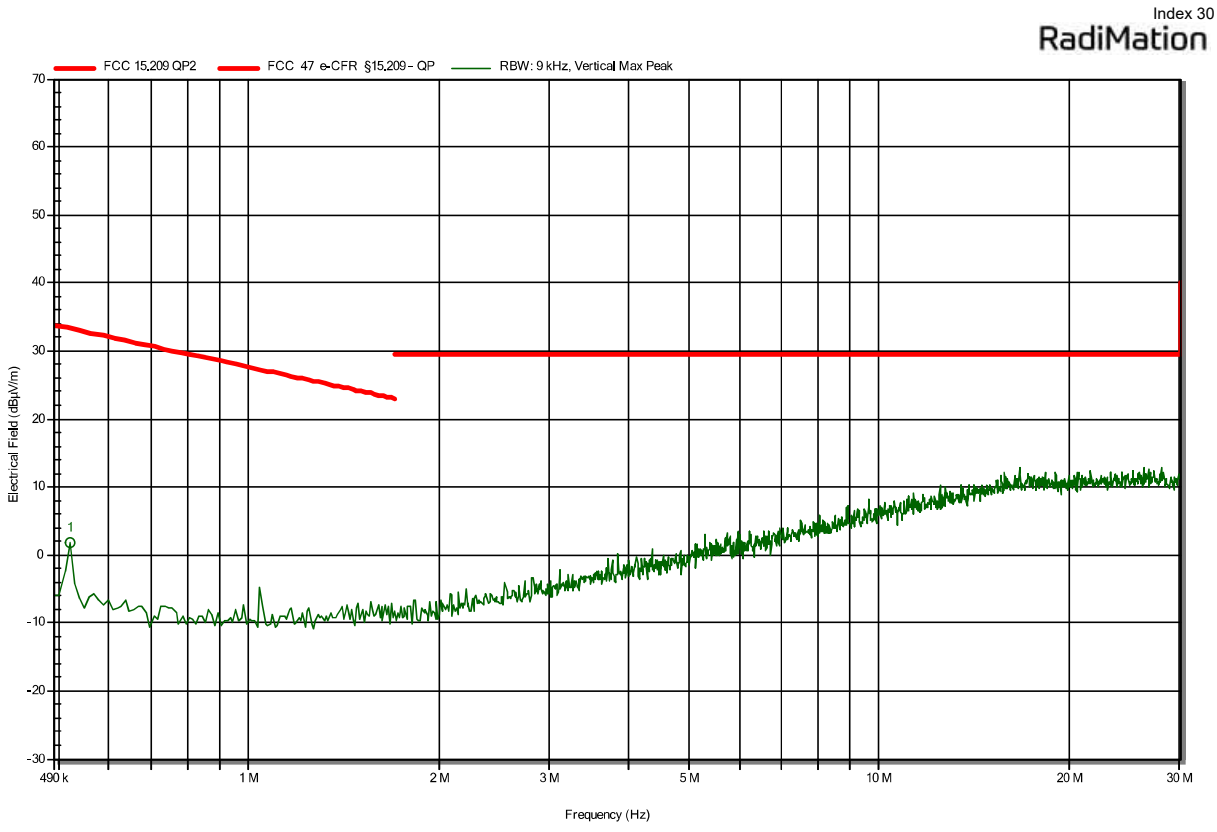


Peak Number	Frequency (MHz)	Peak (dBµV/m)	Peak (dBµV/m)	Limit	Peak (dB)	Difference	Peak Status
1	0.019	-19.1	62		-81.06		Pass

Peak Number	Frequency (MHz)	Average (dBµV/m)	Average (dBµV/m)	Limit	Average (dB)	Difference	Average Status
1	0.019	-19.6	42		-61.59		Pass

Radiated Spurious Emissions according to 47 CFR Part 15.519

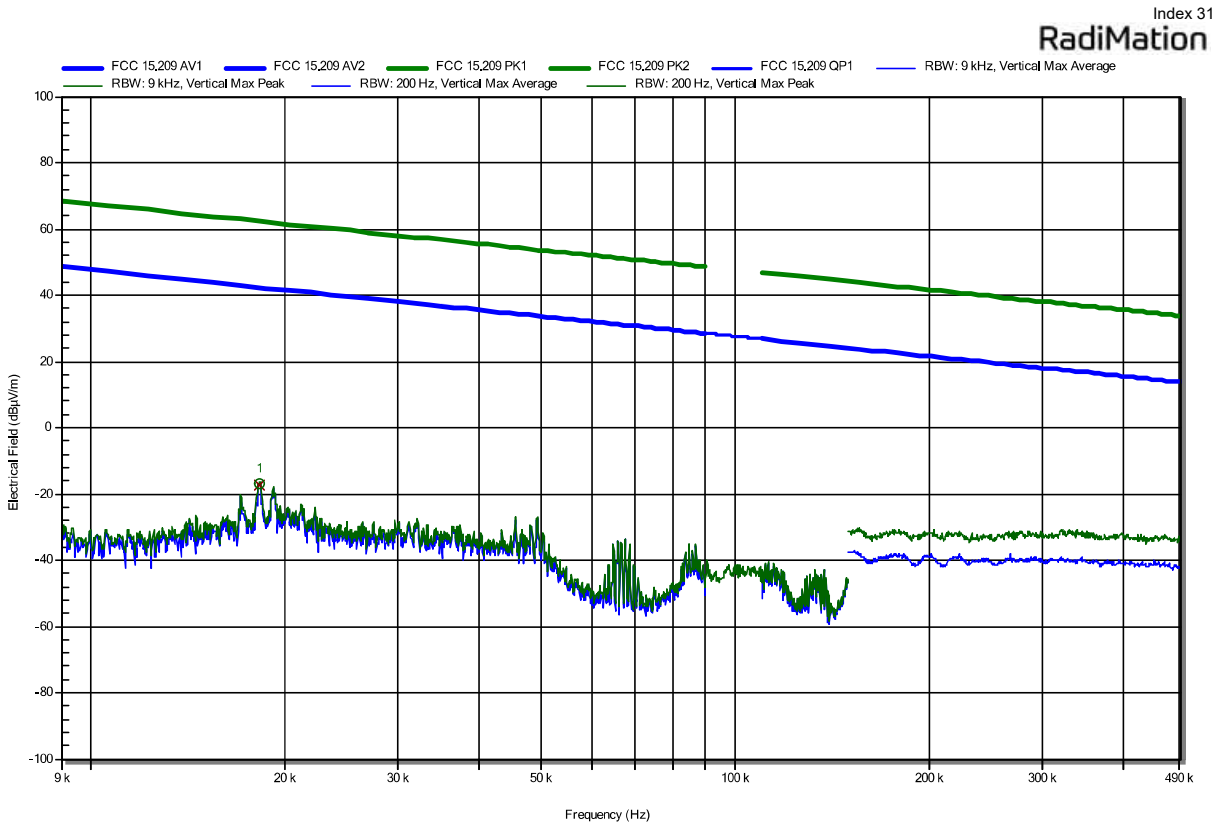
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Rohde & Schwarz HFH 2-Z2, Vertical
Measurement distance:	3 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-26
Note:	Antenna parallel to EUT PCB



Peak Number	Frequency (MHz)	Peak (dBµV/m)	Peak (dBµV/m)	Limit	Peak (dB)	Difference	Peak Status
1	0.52	1.8	33.3		-31.46		Pass

Radiated Spurious Emissions according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Rohde & Schwarz HFH 2-Z2, Vertical
Measurement distance:	3 m, converted to 300 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-26
Note:	Antenna perpendicular to EUT PCB

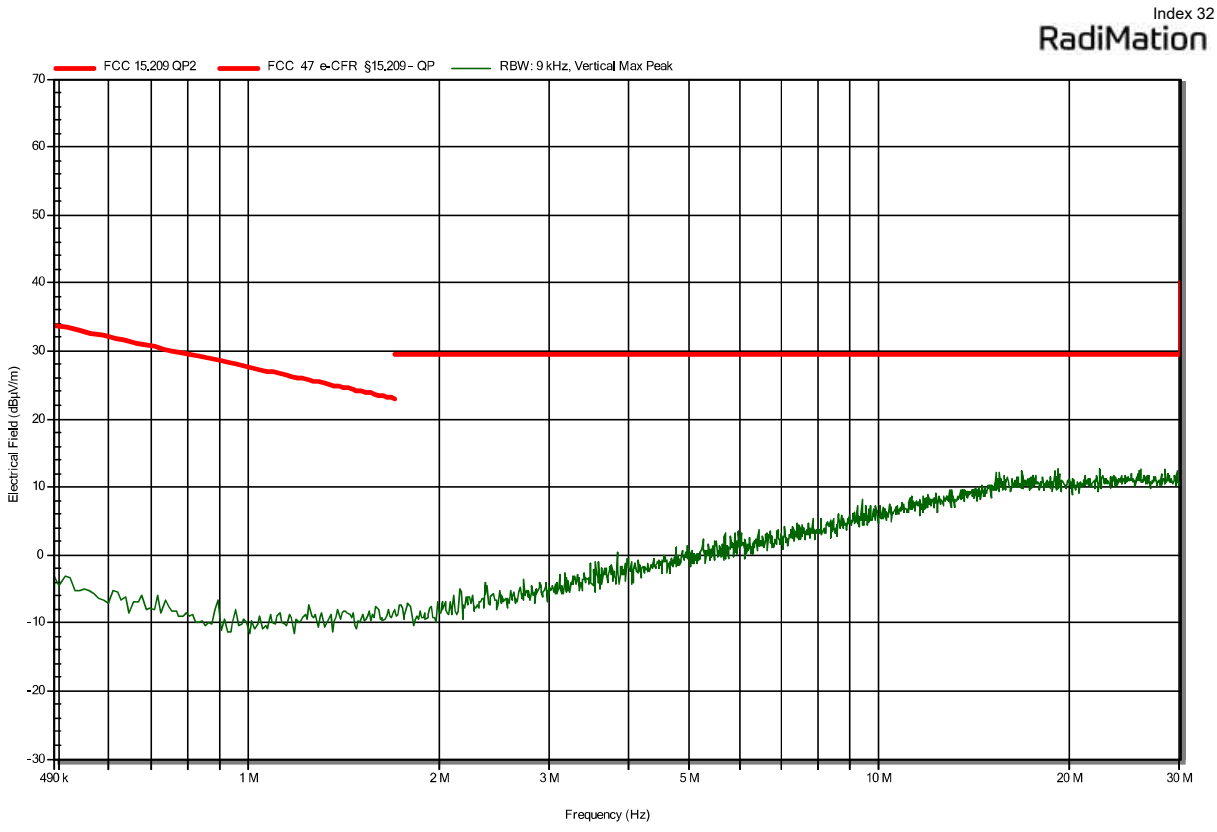


Peak Number	Frequency (MHz)	Peak (dBµV/m)	Peak (dBµV/m)	Limit	Peak (dB)	Difference	Peak Status
1	0.018	-16.9	62.4		-79.27		Pass

Peak Number	Frequency (MHz)	Average (dBµV/m)	Average (dBµV/m)	Limit	Average (dB)	Difference	Average Status
1	0.018	-17.1	42.4		-59.47		Pass

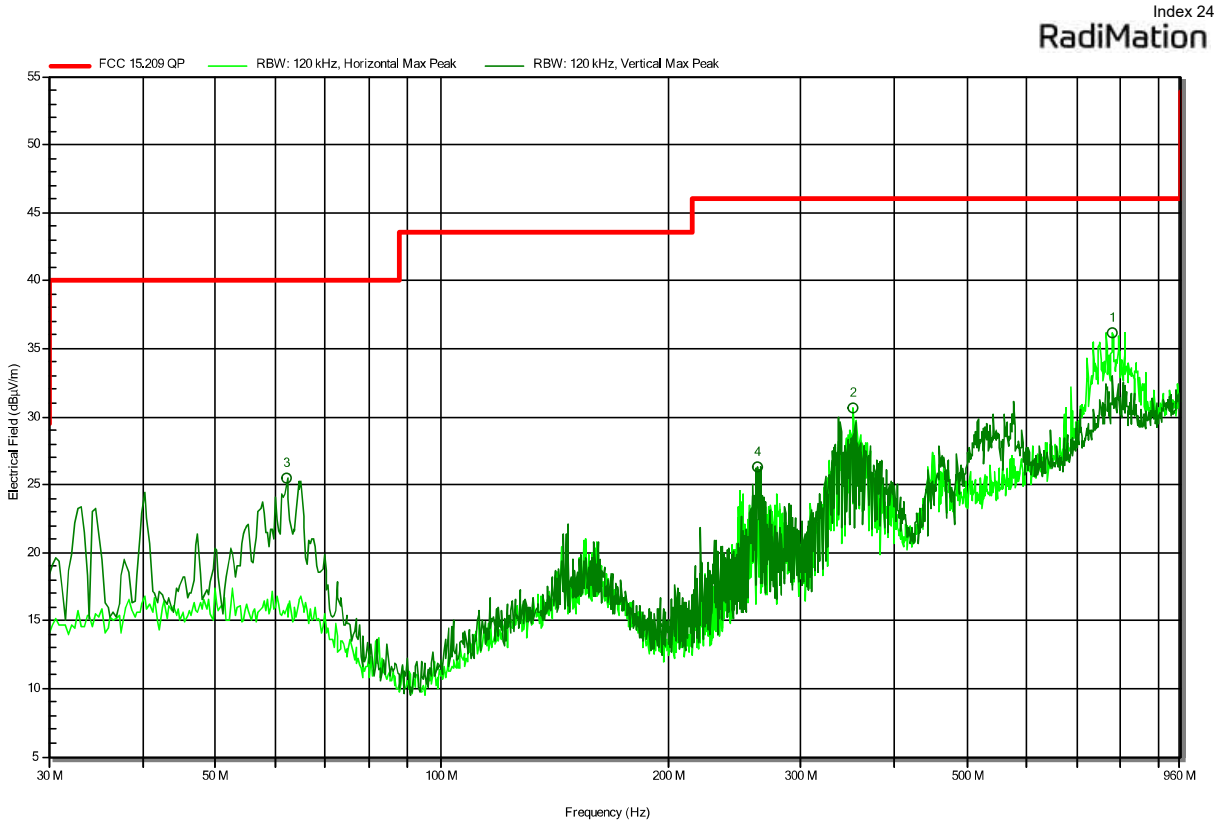
Radiated Spurious Emissions according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Rohde & Schwarz HFH 2-Z2, Vertical
Measurement distance:	3 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-26
Note:	Antenna perpendicular to EUT PCB



Radiated Spurious Emissions according to 47 CFR Part 15.519

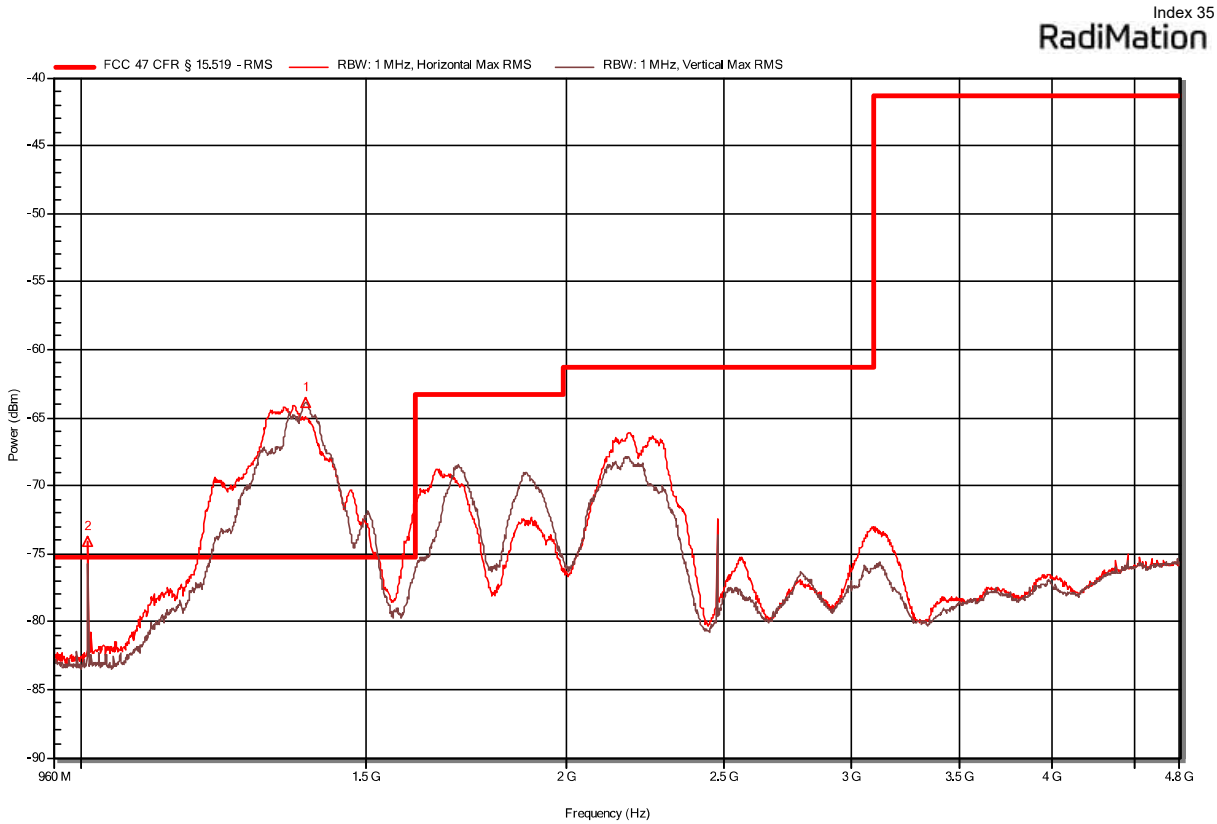
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck VULB 9168
Measurement distance:	3 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-25



Peak Number	Frequency (MHz)	Peak (dBµV/m)	Peak (dBµV/m)	Limit	Peak Difference (dB)	Peak Status	Polarization
1	780.82	36.1	46		-9.89	Pass	Horizontal
2	352.4	30.6	46		-15.37	Pass	Horizontal
3	62.24	25.5	40		-14.54	Pass	Vertical
4	263.43	26.3	46		-19.7	Pass	Vertical

Radiated Spurious Emissions according to 47 CFR Part 15.519

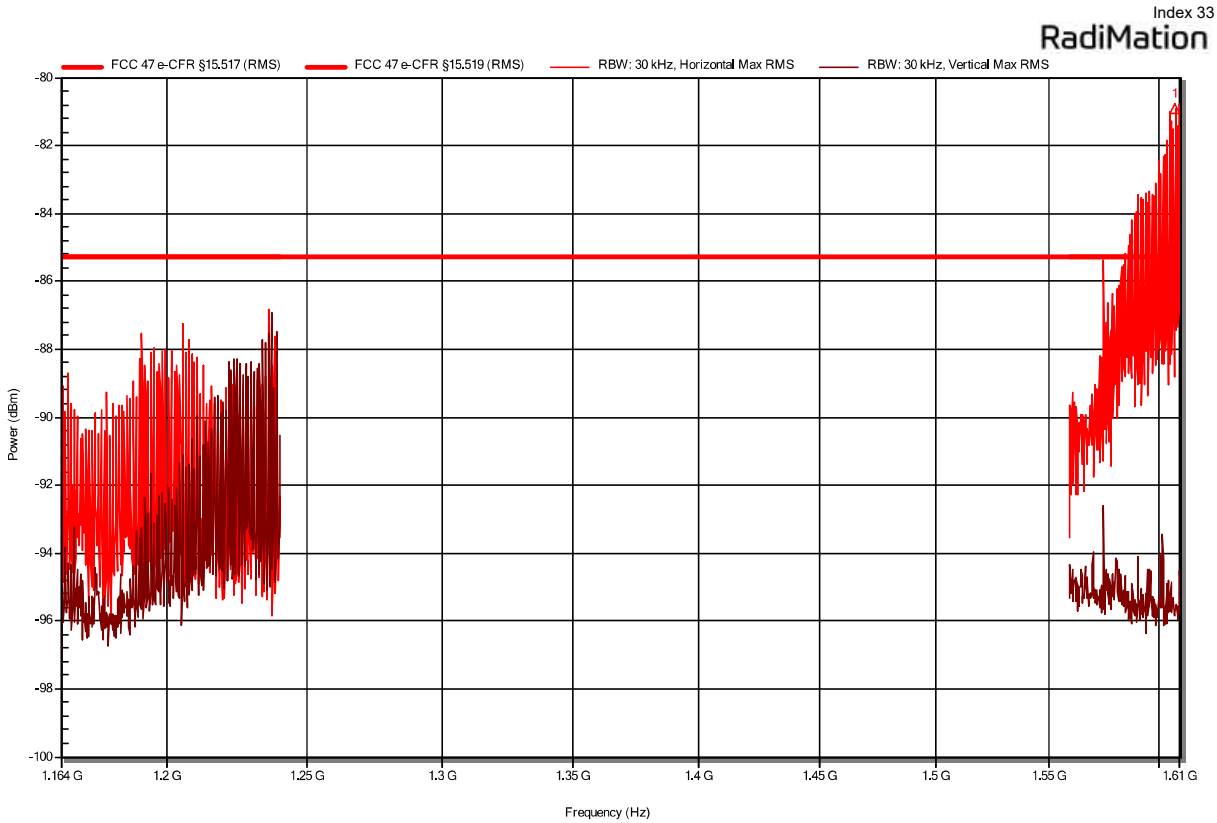
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	1.5 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-29
Note:	Non UWB emissions on plot, see ANNEX B



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS Difference (dB)	RMS Status	Polarization
1	1376.5	-63.8	-75.3		11.46	See ANNEX B	Vertical
2	1008	-74.1	-75.3		1.16	See ANNEX B	Horizontal

Radiated Spurious Emissions according to 47 CFR Part 15.519

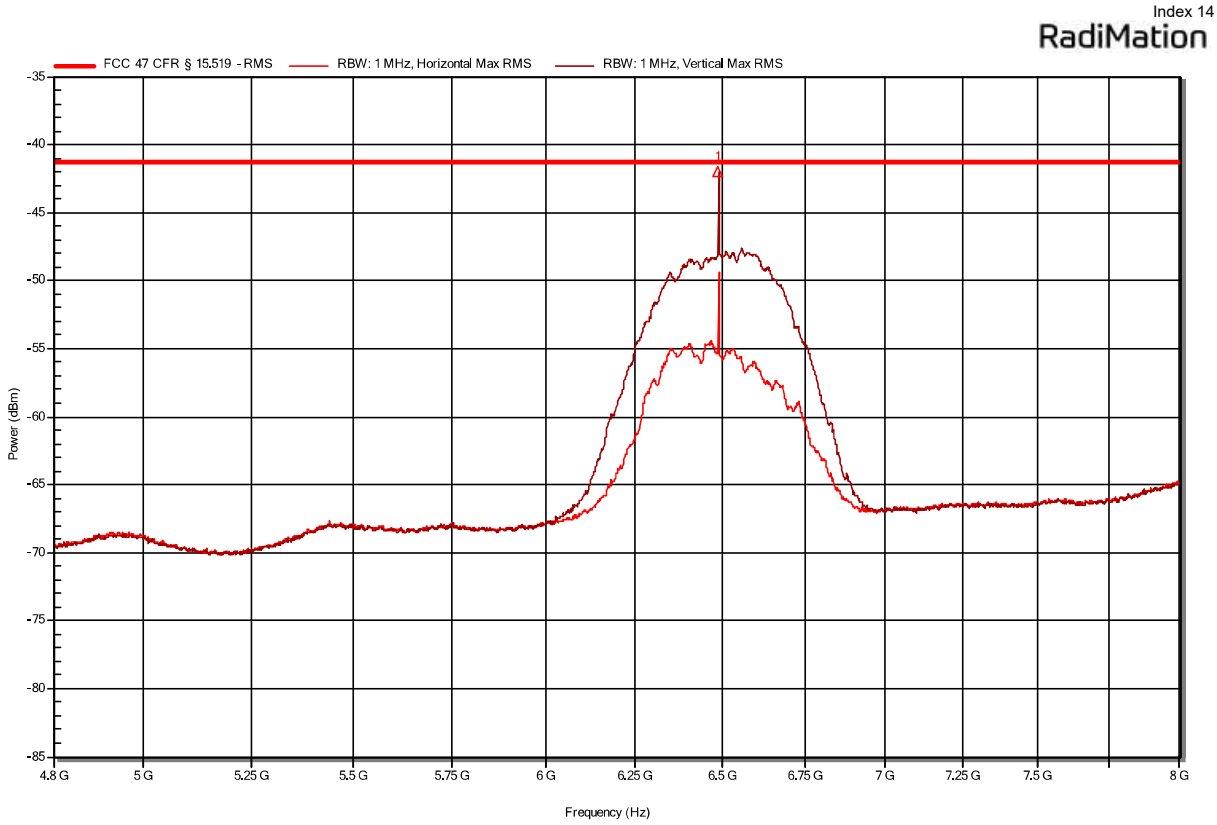
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 23 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	1.5 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-29
Note:	Non UWB emissions on plot, see ANNEX B, page 64 and page 65 for evaluation



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS Difference (dB)	RMS Status	Polarization
1	1607.705	-80.9	-85.3		4.4	See ANNEX B	Horizontal

Radiated Spurious Emissions according to 47 CFR Part 15.519

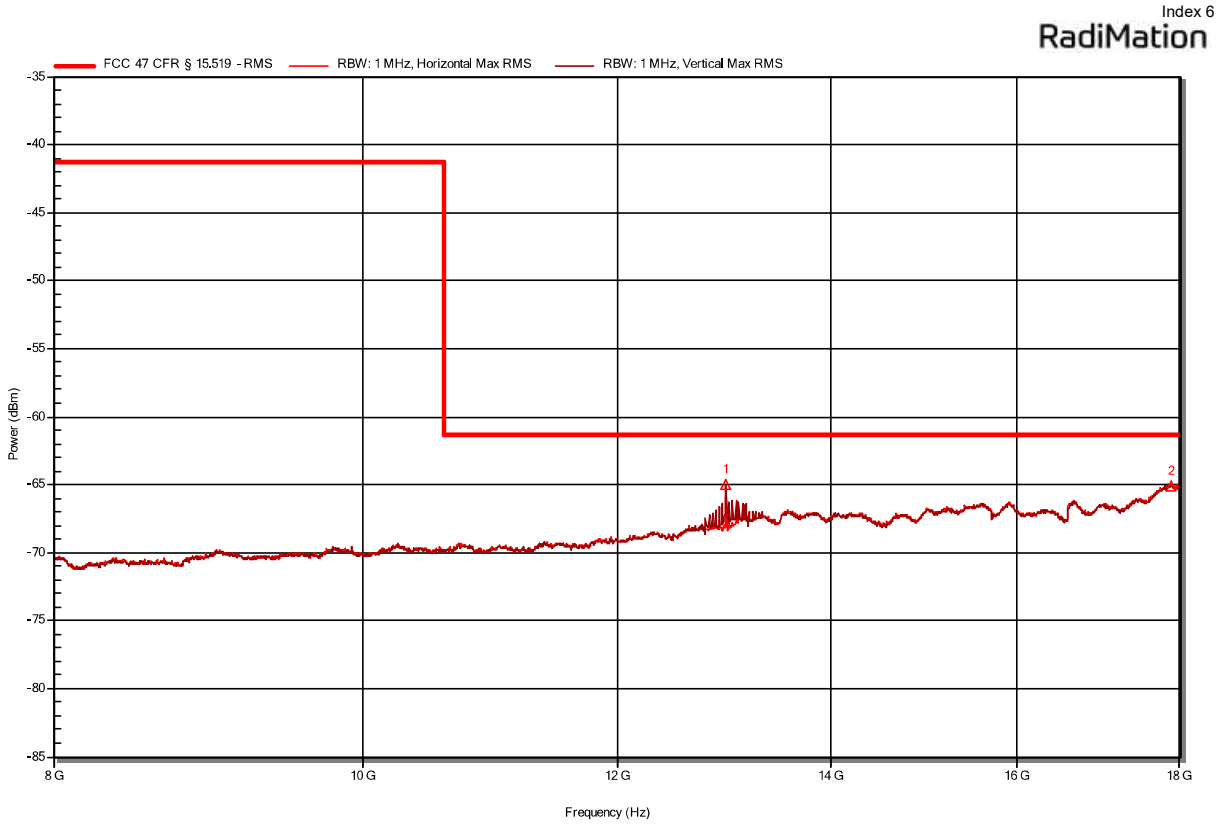
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120B
Measurement distance:	3 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-21



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS (dB)	Difference	RMS Status	Polarization
1	6489.6	-41.9	-41.3		-0.64		Pass	Vertical

Radiated Spurious Emissions according to 47 CFR Part 15.519

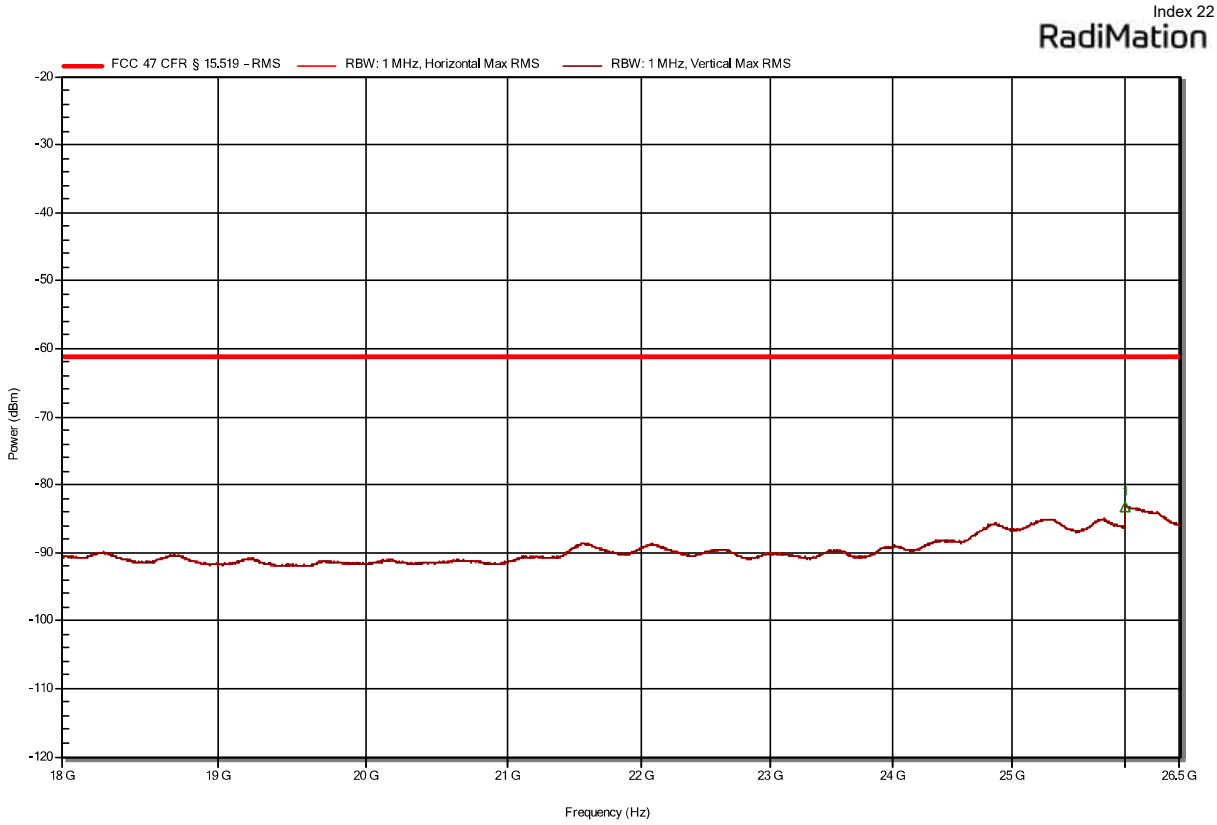
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2020.1.8
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck HWRD 650
Measurement distance:	3 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-20



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS (dB)	Difference	RMS Status	Polarization
1	12979.0975	-65	-61.3		-3.68		Pass	Vertical
2	17893.3333	-65.1	-61.3		-3.81		Pass	Vertical

Radiated Spurious Emissions according to 47 CFR Part 15.519

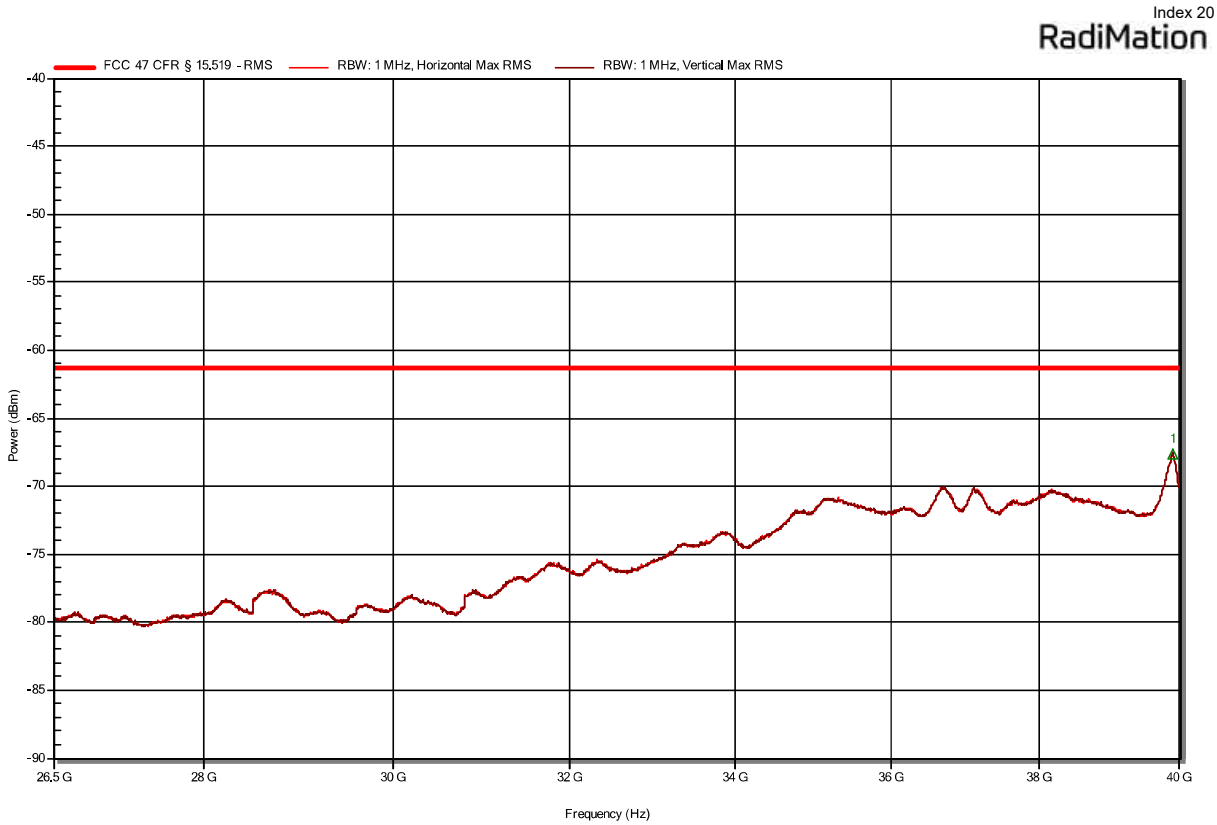
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Amplifier Research AT4560
Measurement distance:	1 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-24



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS Difference (dB)	RMS Status	Polarization
1	26001.333	-83.2	-61.3		-21.89	Pass	Vertical

Radiated Spurious Emissions according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Flann 22240-25
Measurement distance:	1 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB
Test Date:	2024-06-24

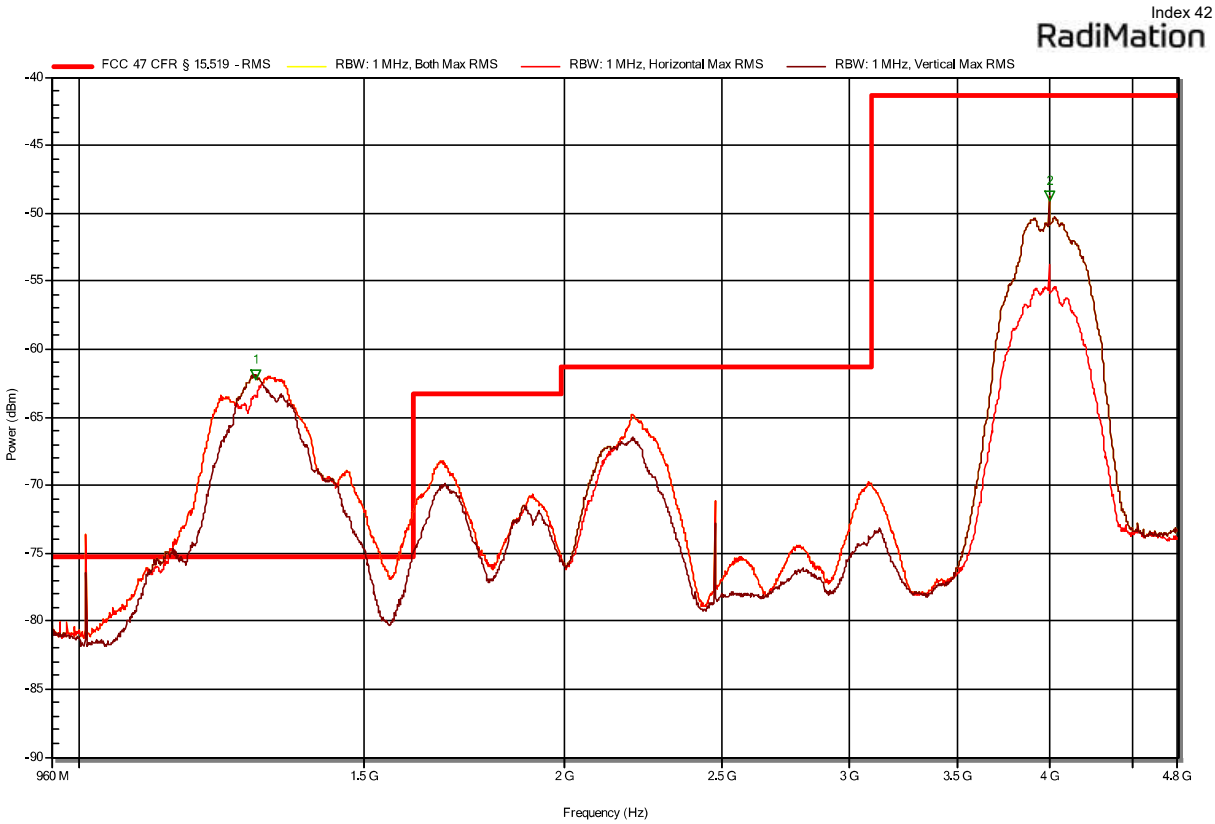


Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS (dB)	Difference	RMS Status	Polarization
1	39899.65	-67.6	-61.3		-6.31		Pass	Vertical

ANNEX B Fail Analysis

Radiated Spurious Emissions according to 47 CFR Part 15.519

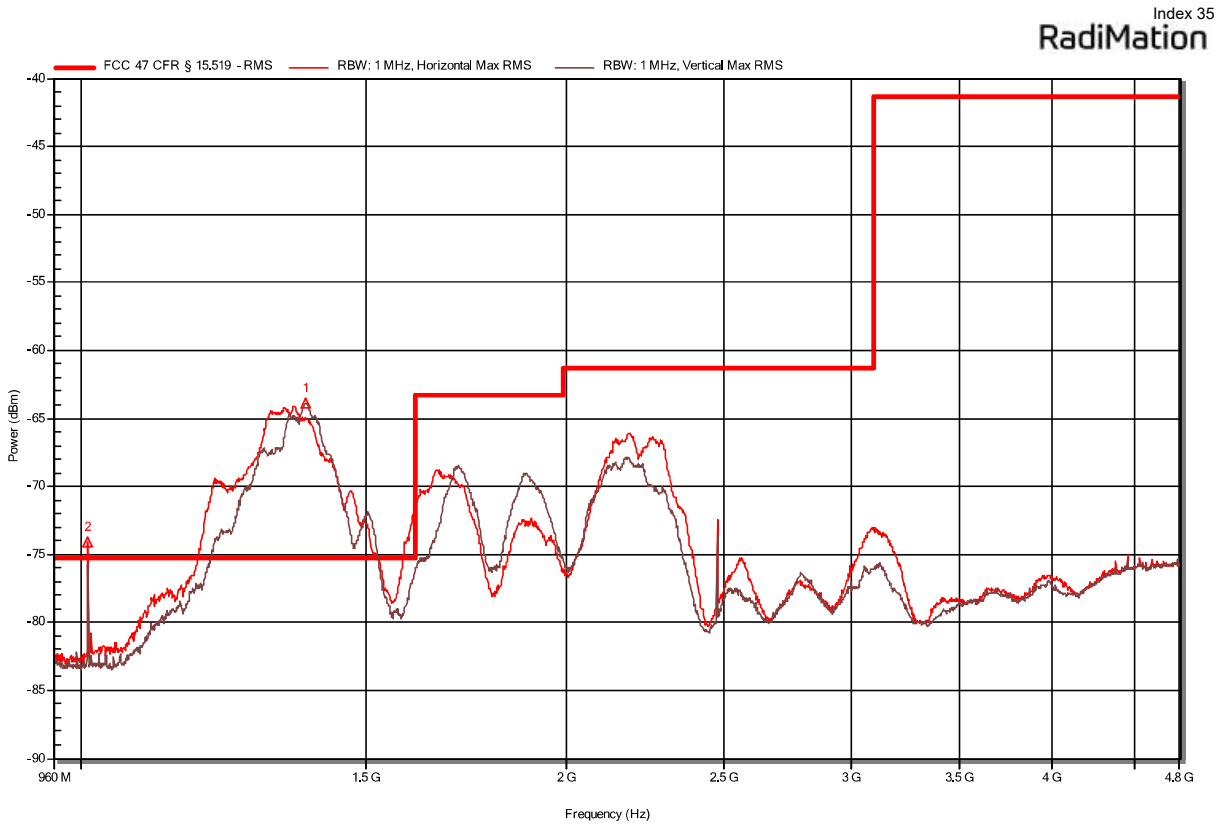
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 24 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	1.5 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB_active
Test Date:	2024-08-02
Note:	UWB radio is active and and Peak 1 is above the limit
Comment	According to 47 CFR Part 15.521, emissions form digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in § 15.209, rather than the limits specified in § 15.519. To prove that the emission is not from UWB transmitter, The measurement was repeated with UWB transmitter turned off and § 15.209 limit was used (Results at page 63).



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS Difference (dB)	RMS Status	Polarization
1	1285.376	-61.9	-75.3		13.45	Fail (UWB ON)	Vertical
2	3993.6	-48.8	-41.3		-7.48	Pass	Vertical

Radiated Spurious Emissions according to 47 CFR Part 15.519

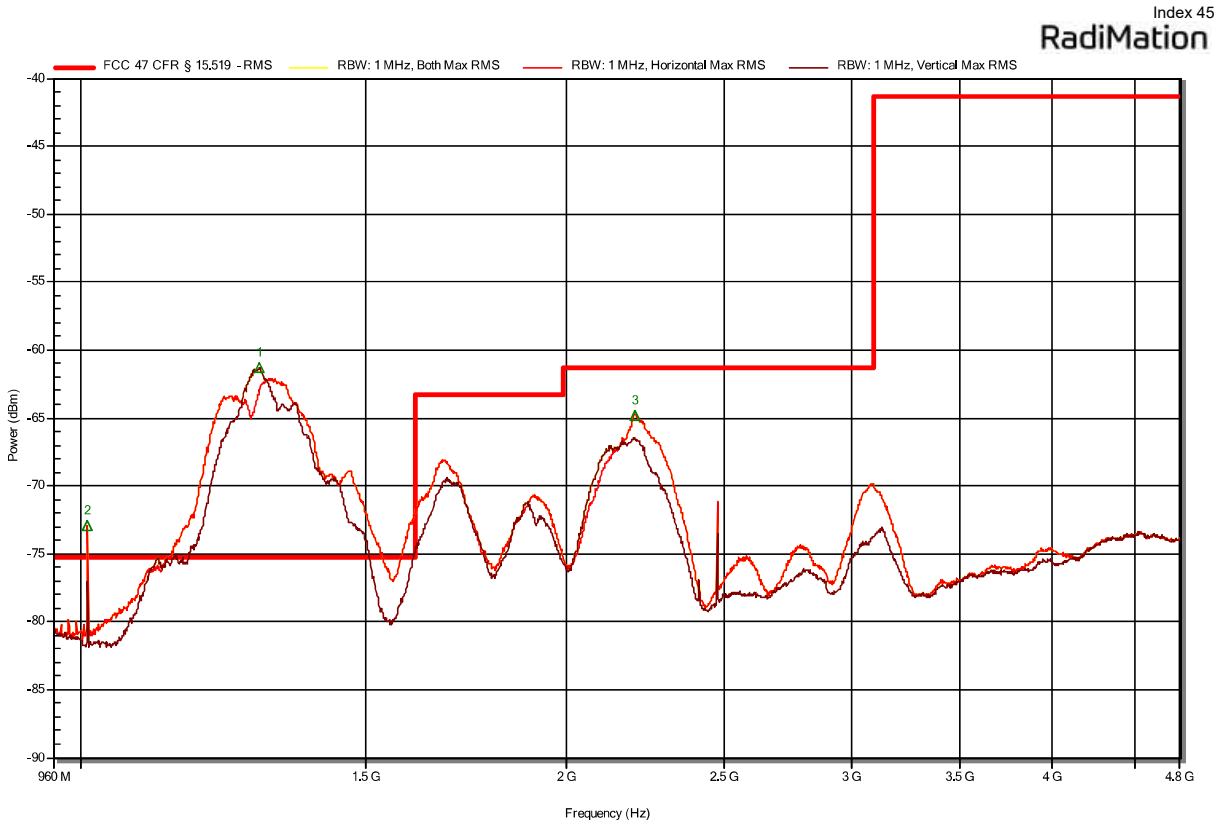
Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 25 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	1.5 m
Mode:	Tx; 6489.6 MHz, BPSK, UWB active
Test Date:	2024-06-29
Note:	UWB radio is active and and Peak 1 is above the limit
	According to 47 CFR Part 15.521, emissions form digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in § 15.209, rather than the limits specified in § 15.519. To prove that the emission is not from UWB transmitter, The measurement was repeated with UWB transmitter turned off and § 15.209 limit was used (Results at page 63).



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS Difference (dB)	RMS Status	Polarization
1	1376.5	-63.8	-75.3		11.46	Fail (UWB ON)	Vertical
2	1008	-74.1	-75.3		1.16	Fail (UWB ON)	Horizontal

Radiated Spurious Emissions according to 47 CFR Part 15.519

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 24 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	1.5 m
Mode:	UWB_inactive
Test Date:	2024-08-02
Note:	UWB transmitter was deactivated, but same behavior was observed. Emission at Peak 1 and 2 is not produced by the UWB transmitter, because the UWB transmitter is inactive.



Peak Number	Frequency (MHz)	RMS (dBm)	RMS (dBm)	Limit	RMS Difference (dB)	RMS Status	Polarization
1	1289.984	-61.2	-75.3		14.05	Fail (UWB OFF)	Vertical
2	1007.872	-72.9	-75.3		2.43	Fail (UWB OFF)	Horizontal
3	2202.496	-64.8	-61.3		-3.47	Pass	Horizontal

Radiated Spurious Emissions according to 47 CFR Part 15.521

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 24 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB_inactive
Test Date:	2024-10-04
Note:	UWB transmitter was deactivated, and measurement was done with § 15.519 limit line. In this case Peak 2 is below the limit line. Emission at Peak 2 is not produced by the UWB transmitter, because the UWB transmitter is inactive.

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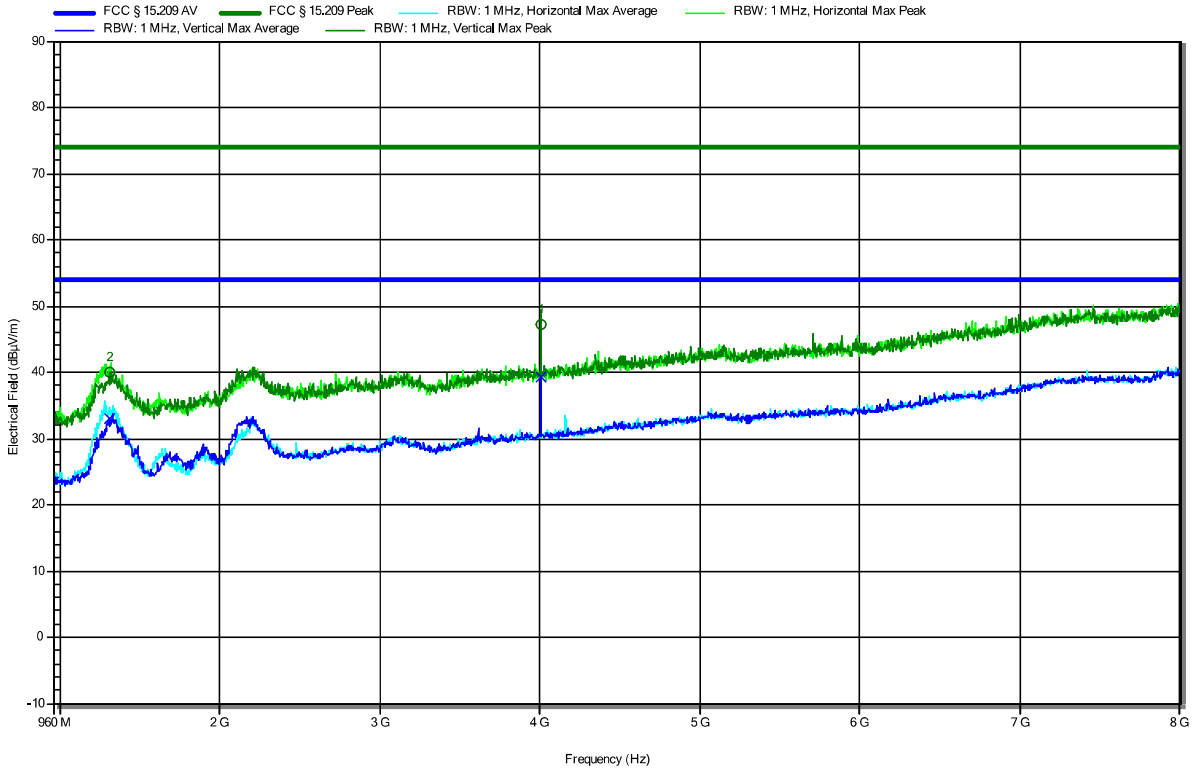
RadiMation

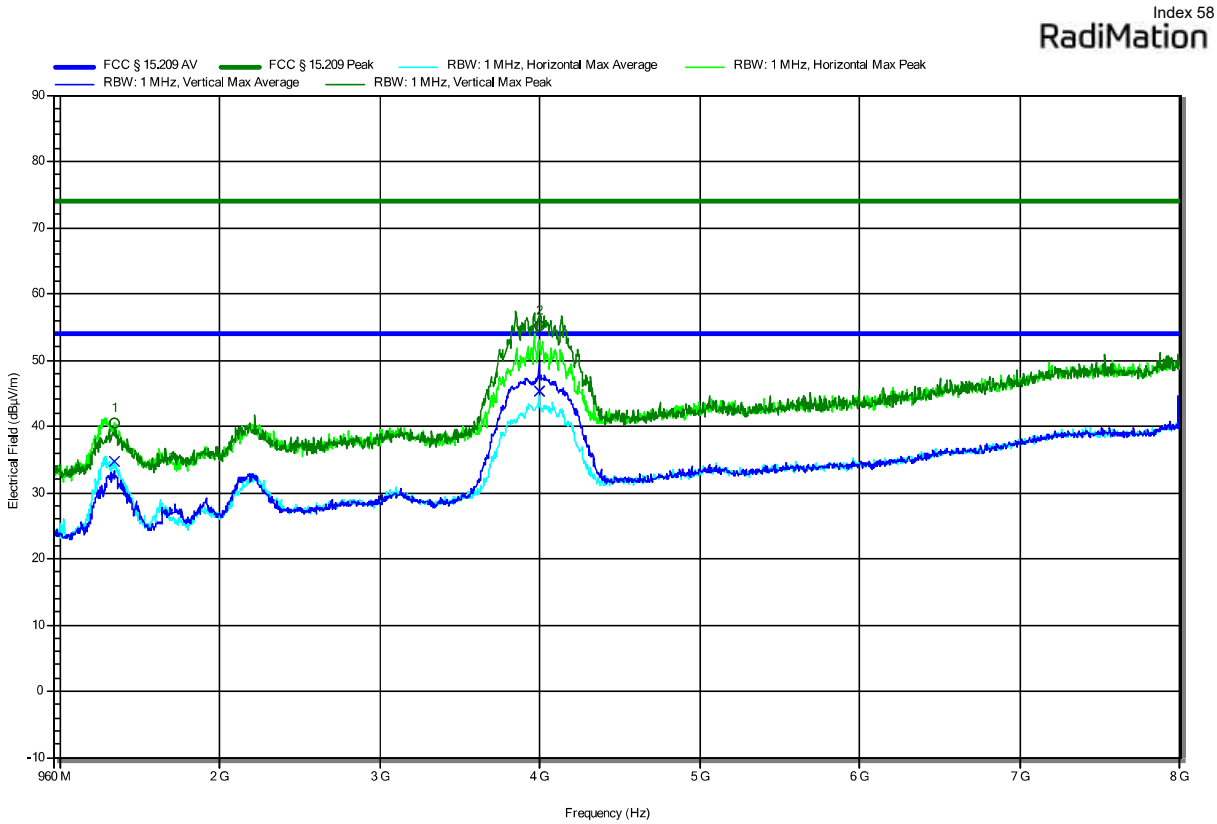


Peak Number	Frequency (MHz)	Peak (dBµV/m)	Peak (dBµV/m)	Limit	Peak Difference (dB)	Peak Status	Polarization
1	4007.381	47.14	74		-26.86	Pass	Vertical
2	1308.48	40.1	74		-33.9	Pass	Vertical

Peak Number	Frequency (MHz)	Average (dBµV/m)	Average (dBµV/m)	Limit	Average Difference (dB)	Average Status	Polarization
1	4007.381	39.39	53.98		-14.59	Pass	Vertical
2	1308.48	33.04	53.98		-20.94	Pass	Vertical

Radiated Spurious Emissions according to 47 CFR Part 15.521

Project Number:	G0M-2403-2508
Applicant:	Jungheinrich AG
Model Description:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445052, Truck Tag
Test Sample ID:	48550
Test Site:	Eurofins Product Service GmbH
Operator:	Mr. Siddique
Measurement software:	RadiMation, version 2023.2.6
Test Conditions:	Tnom: 24 °Celsius, Vnom: 24 V DC
Antenna:	Schwarzbeck BBHA 9120D
Measurement distance:	3 m
Mode:	Tx; 3993.6 MHz, BPSK, UWB_active
Test Date:	2024-10-04
Note:	UWB transmitter was activated (for comparison)



Peak Number	Frequency (MHz)	Peak (dBµV/m)	Peak (dBµV/m)	Limit	Peak Difference (dB)	Peak Status	Polarization
1	1341.333	40.4	74		-33.6	Pass	Horizontal
2	3993.301	55.12	74		-18.88	Pass	Vertical

Peak Number	Frequency (MHz)	Average (dBµV/m)	Average (dBµV/m)	Limit	Average Difference (dB)	Average Status	Polarization
1	1341.333	34.62	53.98		-19.36	Pass	Horizontal
2	3993.301	45.22	53.98		-8.76	Pass	Vertical

====== End of test report ======