



RF - TEST REPORT

- FCC Part 15.249, RSS210 -

Type / Model Name : TS760

Product Description : Touch probe 2.4 GHz

Applicant : DR. JOHANNES HEIDENHAIN GmbH

Address : Dr. Johannes-Heidenhain-Str. 5
83301 TRAUNREUT

Manufacturer : DR. JOHANNES HEIDENHAIN GmbH

Address : Dr. Johannes-Heidenhain-Str. 5
83301 TRAUNREUT

Test Result according to the standards listed in clause 1 test standards:	POSITIVE
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Test Report No. : 80085827-02 Rev_0	29. July 2021 Date of issue
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Deutsche
Akkreditierungsstelle
D-PL-12030-01-03
D-PL-12030-01-04



FCC ID: YJKTSX6TTX6 IC: 11148A-TSX6TTX6

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ATTACHMENT A as separate supplement



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1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September 2020)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (September 2020)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
Part 15, Subpart C, Section 15.215	Additional provisions to the general radiated emission limitations
Part 15, Subpart C, Section 15.249	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, 5725 - 5875 MHz, and 24.0 - 24.25 GHz
ANSI C63.10: 2013	Testing Unlicensed Wireless Devices
ETSI TR 100 028 V1.3.1: 2001-03	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2



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2 EQUIPMENT UNDER TEST

2.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

2.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

2.3 General remarks

The EUT is has got a new sensor PCB and a new model TS760 is added but the RF-unit is not modified. This test report shows the further compliance to the FCC 15.249. Therefore, the additional requirements are tested, only.

- Output power
- Spurious emission

2.4 Photo documentation of the EUT – Detailed photos see attachment A

2.5 Equipment category

EUT is a short-range device.

2.6 Short description of the equipment under test (EUT)

The EUT is a wireless touch probe for low power data transmission.

Number of tested samples: 1 radiated samples
 Serial number: 75 160 536

EUT configuration:

(The CDF filled by the applicant can be viewed at the test laboratory.)

2.7 Variants of the EUT

There are the following variants:

Type	Comment
TS 460	Touch probe system for mounting in the spindle
TS 462	Like TS460 with activation through taper shank switch
TT 460	Used for tool measurement, mounted in the working space
TS 760	For mounting in the spindle with higher accuracy

For testing the variant TS760 is used.



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2.8 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel plan:

Channel	Frequency	Channel	Frequency
0	2405	8	2445
1	2410	9	2450
2	2415	10	2455
3	2420	11	2460
4	2425	12	2465
5	2430	13	2470
6	2435	14	2475
7	2440	15	2480

Note: the marked frequencies are determined for final testing.

2.9 Transmit operating modes

O-QPSK modulation with 250 kbps.

2.10 Antenna

The following integrated antenna is used with the EUT:

- PCB meander antenna

2.11 Power supply system utilised

Power supply voltage, V_{nom} : 1.5 VDC (Alkaline battery)

2.12 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- - - Model : -

2.13 Determination of worst-case conditions for final measurement

Measurements have been made in all three orthogonal axes and the settings of the EUT were changed to locate at which position and at what setting of the EUT produce the maximum of the emissions. For the further measurement the EUT is set in Y position with the maximum output power

For the final test, the following channels and test modes are selected:

Standard	Available channels	Tested channels	Power setting	Modulation	Modulation type	Data rate
Proprietary	0 to 15	0, 7, 15	max	O-QPSK	digital	250 kbps



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2.13.1 Test jig

No test jig is used.

2.13.2 Test software

No test software for the EUT is needed. After battery is plugged in, The EUT starts to transmit continuously. By moving the sensor tip the channel counts up.



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3 TEST RESULT SUMMARY

Operating in the 2400 MHz – 2483.5 MHz band:

FCC Rule Part	RSS Rule Part	Description	Result
15.205(a)	RSS-Gen, 8.10	Emissions in restricted bands	passed
15.207(a)	RSS-Gen, 8.8	AC power line conducted emissions	not applicable
15.215(c)	-	EBW	Not tested
-	RSS-Gen, 6.6	OBW	Not tested
15.249(a)	RSS-210, B10(a)	Field strength of fundamental	passed
15.249(d)	RSS-210, B10(b)	Out-of-band emission, radiated	passed
15.215	RSS-Gen, 8.11	Transmitter frequency stability	not applicable

The mentioned RSS Rule Parts in the above table are related to:

RSS-Gen, Issue 5 + Amendment 1, March 2019

RSS-210, Issue 10, Amendment 1, 2019

3.1 Final assessment

The equipment under test fulfills the requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 14 July 2021

Testing concluded on : 15 July 2021

Checked by: _____ Tested by: _____

Klaus Gegenfurtner
Teamleader Radio

Hermann Smetana Radio Team



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4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15 - 35 ° C

Humidity: 30 - 60 %

Atmospheric pressure: 86 - 106 kPa

4.1 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor $k = 2$. The true value is located in the corresponding interval with a probability of 95 %. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 2011 + A1 / 2014 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
AC power line conducted emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
EBW and OBW	2400 MHz to 30000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Output power ERP, radiated	1000 MHz to 7000 MHz	95%	± 2.71 dB
Field strength of the fundamental	1000 MHz to 7000 MHz	95%	± 2.71 dB
Power spectral density	2400 MHz to 3000 MHz	95%	± 0.62 dB
Spurious Emissions, conducted	9 kHz to 10000 MHz	95%	± 2.15 dB
Spurious Emissions, conducted	10000 MHz to 40000 MHz	95%	± 3.47 dB
Spurious Emissions, radiated	9 kHz to 30 MHz	95%	± 3.53 dB
Spurious Emissions, radiated	30 MHz to 1000 MHz	95%	± 4.44 dB
Spurious Emissions, radiated	1000 MHz to 30000 MHz	95%	± 2.34 dB
Spurious Emissions, radiated	30000 MHz to 40000 MHz	95%	± 5.13 dB

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4.2 Conformity Decision Rule

The conformity decision rule is based on the ILAC G8 published at the time of reporting.

4.3 Measurement protocol for FCC and ISED

4.3.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

**FCC: DE 0011
ISED: DE0009**

4.3.2 General Standard information

The test methods used comply with ANSI C63.10 - "Testing Unlicensed Wireless Devices".

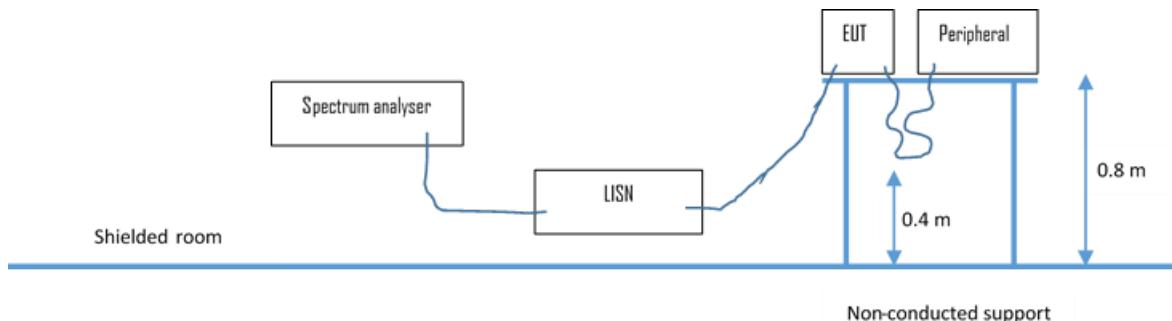
4.3.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.3.3 Details of test procedures

4.3.3.1 Conducted emission

Test setup according ANSI C63.10



The final level, expressed in $\text{dB}\mu\text{V}$, is arrived at by taking the reading directly from the Spectrum analyser. This level is compared to the limit.

To convert between $\text{dB}\mu\text{V}$ and μV , the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with $50 \Omega / 50 \mu\text{H}$ (CISPR 16) characteristics. The receiver is protected by means of an impedance matched pulse limiter connected directly to the RF input. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emission is re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

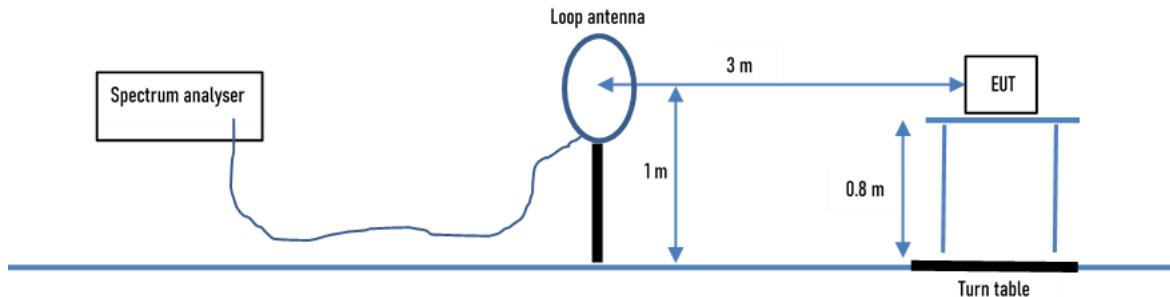
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4.3.3.2 Radiated emission

4.3.3.2.1 OATS1 test site (9 kHz - 30 MHz):

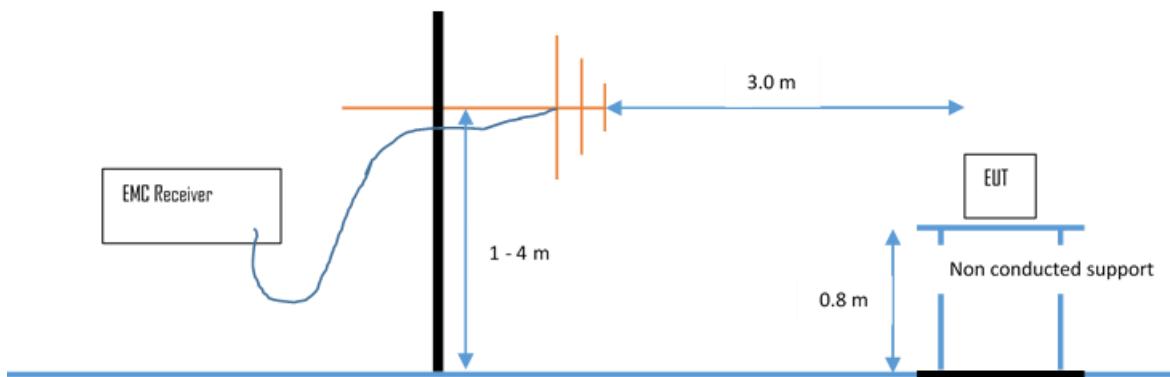
Test setup according ANSI C63.10



Emissions from the EUT are measured in the frequency range of 9 MHz to 30 MHz using a tuned receiver and a calibrated loop antenna. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied along the site axis and the EUT is rotated 360 degrees.

4.3.3.2.2 OATS1 test site (30 MHz - 1 GHz):

Test setup according ANSI C63.10.



Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees. The final level in dB μ V/m is calculated by taking the reading from the EMI receiver (Level dB μ V) and adding the correction factors and cable loss factor (dB). The FCC limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:

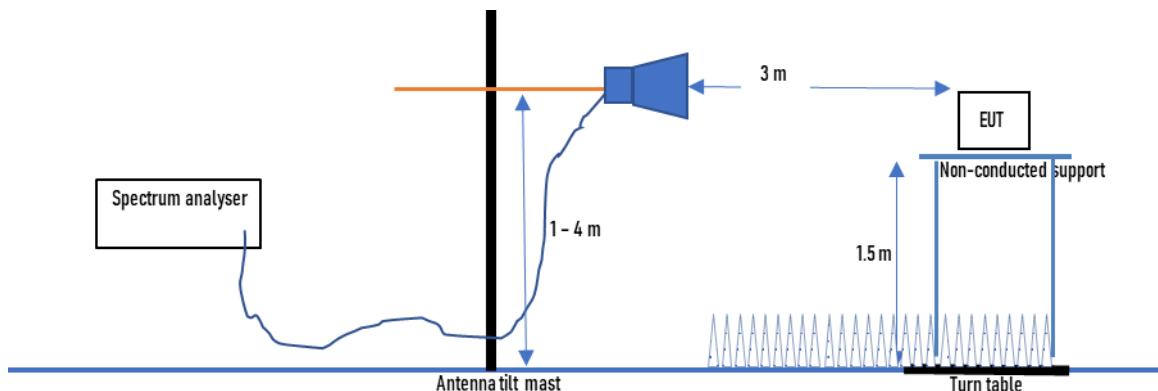
30 MHz – 1000 MHz: RBW: 120 kHz

Example:

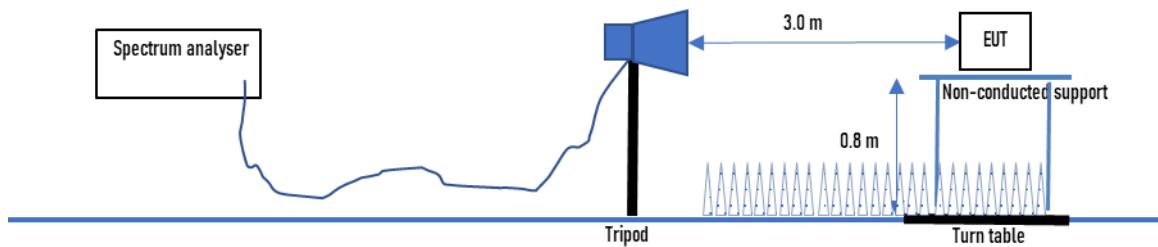
Frequency (MHz)	Level (dB μ V)	+	Factor (dB)	=	Level (dB μ V/m)	-	Limit (dB μ V/m)	=	Delta (dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	=	-2.4

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4.3.3.2.3 Anechoic chamber 1 (1000 MHz – 18000 MHz)

Test setup according ANSI C63.10.



Radiated emissions from the EUT are measured in the frequency range 1 GHz up to 18 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 1.5 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the center, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements.

4.3.3.2.4 Anechoic chamber 1 (18 GHz – 40 GHz)


Emissions from the EUT are measured in the frequency range 18 GHz up to 40 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 0.8 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the center, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty. The limit is adopted.



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5 TEST CONDITIONS AND RESULTS

5.1 AC power line conducted emissions

For test instruments and accessories used see section 6 Part A 4.

5.1.1 Description of the test location

Test location: NONE

Remarks: For detailed test result please refer to following test protocols

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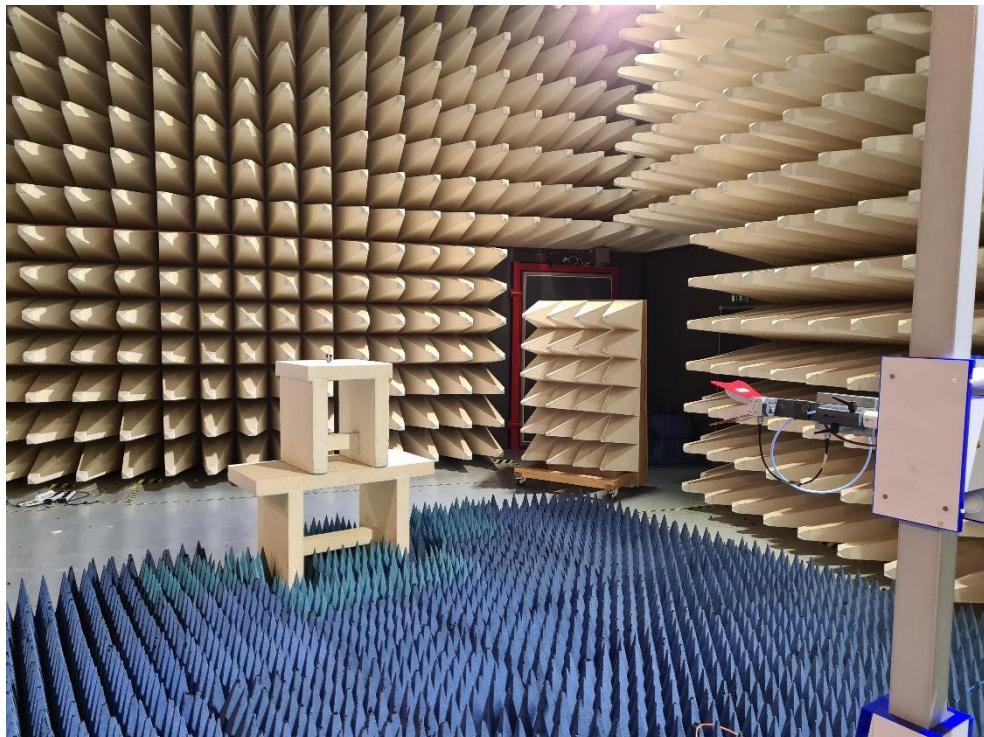
5.2 Field strength of fundamental

For test instruments and accessories used see section 6 Part **CPR 3**.

5.2.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.2.2 Photo documentation of the test set-up





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5.2.1 Applicable standard

According to FCC Part 15C, Section 15.249(a):

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the effective limits.

5.2.2 Description of Measurement

The radiated emission of the fundamental wave from the EUT is measured using a spectrum analyser and appropriate linear polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.10, Item 6.5. The EUT is measured in TX continuous mode unmodulated under normal conditions.

Analyser settings:

Peak measurement:	RBW: 1 MHz	VBW: 1 MHz	Detector: Max peak
AV measurement:	RBW: 1 MHz	VBW: 10 Hz	Detector: Max peak

5.2.3 Test result

The duty cycle factor (dB) is calculated applying the following formula:

$$KE = 20 \log (\max \text{ On-time}/T_w);$$

KE : pulse operation correction factor

T_w : a period of the pulse track

Total length of period	3.039 ms
Max. On time Port4	0.640 ms
DC	0.21
Correction factor	-13.5 dB

Output power:

Frequency (MHz)	Level PK dB(μ V/m)	Limit PK dB(μ V/m)	Margin PK (dB)	Level AV dB(μ V/m)	Limit AV dB(μ V/m)	Margin AV (dB)
2405	92.5	114.0	-21.5	79.0	94.0	-15.0
2440	91.7	114.0	-22.3	78.2	94.0	-15.8
2480	90.0	114.0	-24.0	76.5	94.0	-17.5

Note: The correction factor 13.5 dB is used to calculate the AV level.



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Average-Limit according to FCC Part 15C, Section 15.249(a):

Frequency (MHz)	Field strength of fundamental	
	(mV/m)	dB(µV/m)
902 - 928	50	94
2400 - 2483.5	50	94
5725-5875	50	94
24000 - 24250	250	108

Peak-Limit according to FCC Part 15C, Section 15.249(e):

However, the peak fieldstrength shall not exceed the maximum permitted average limit by more than 20 dB.

The requirements are **FULFILLED**.

Remarks:

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5.3 Out-of-band emission, radiated

For test instruments and accessories used see section 6 Part **SER1, SER 2, SER 3**.

5.3.1 Description of the test location

Test location: OATS 1
 Test location: Anechoic chamber 1
 Test distance: 3 m

5.3.2 Photo documentation of the test set-up

Test setup 30 MHz – 1000 MHz:

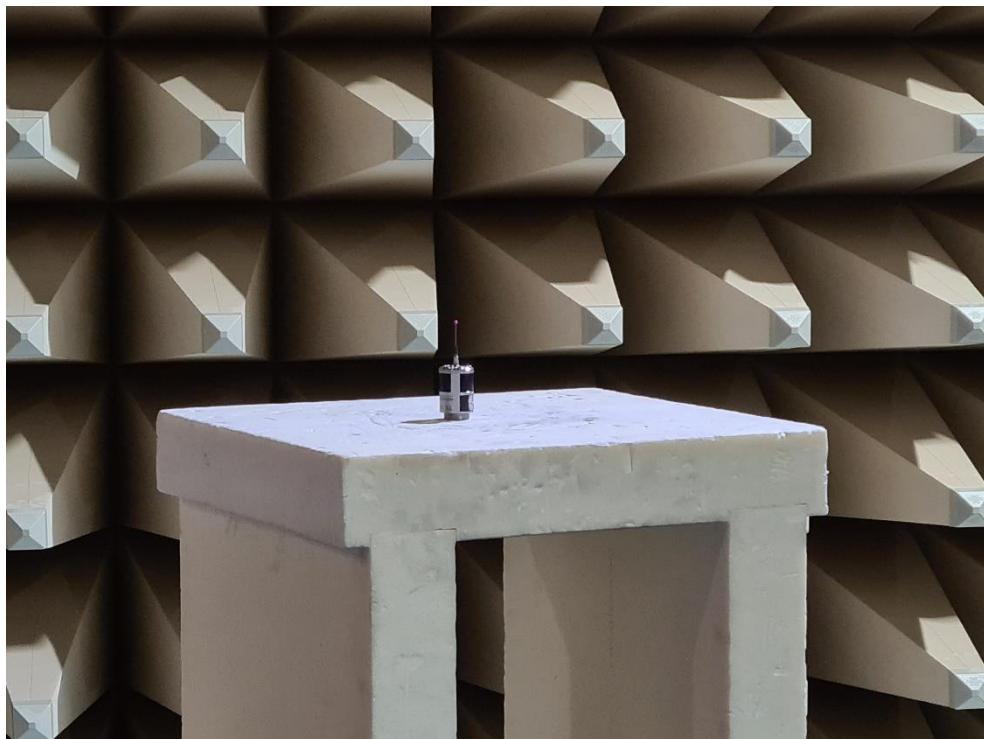
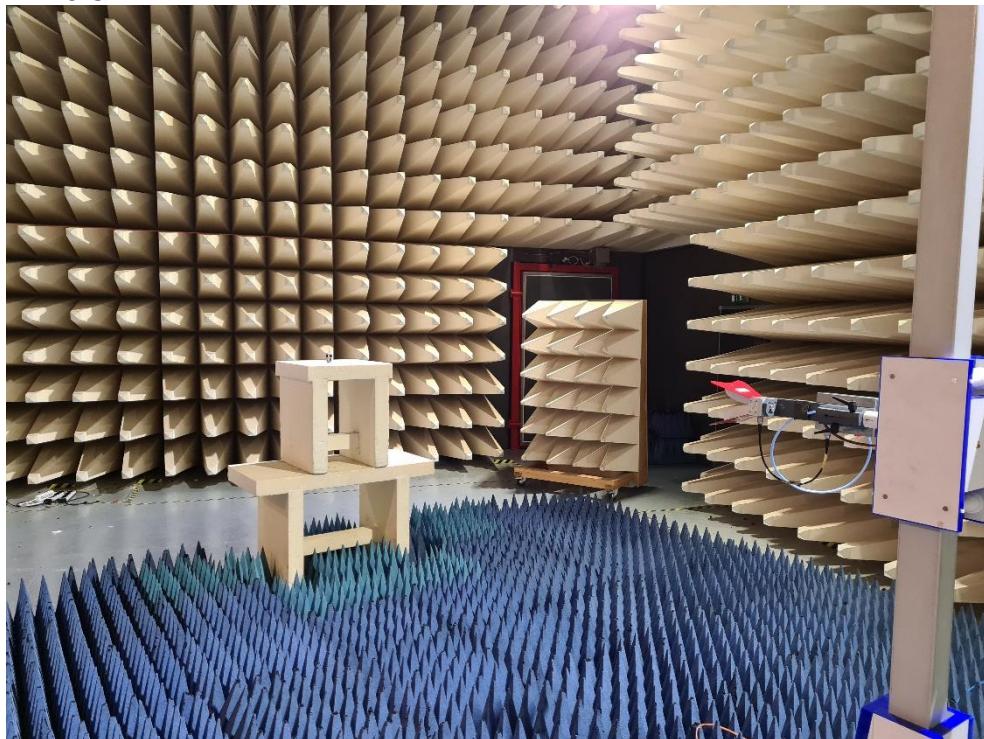




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Test setup 1 GHz – 18 GHz:

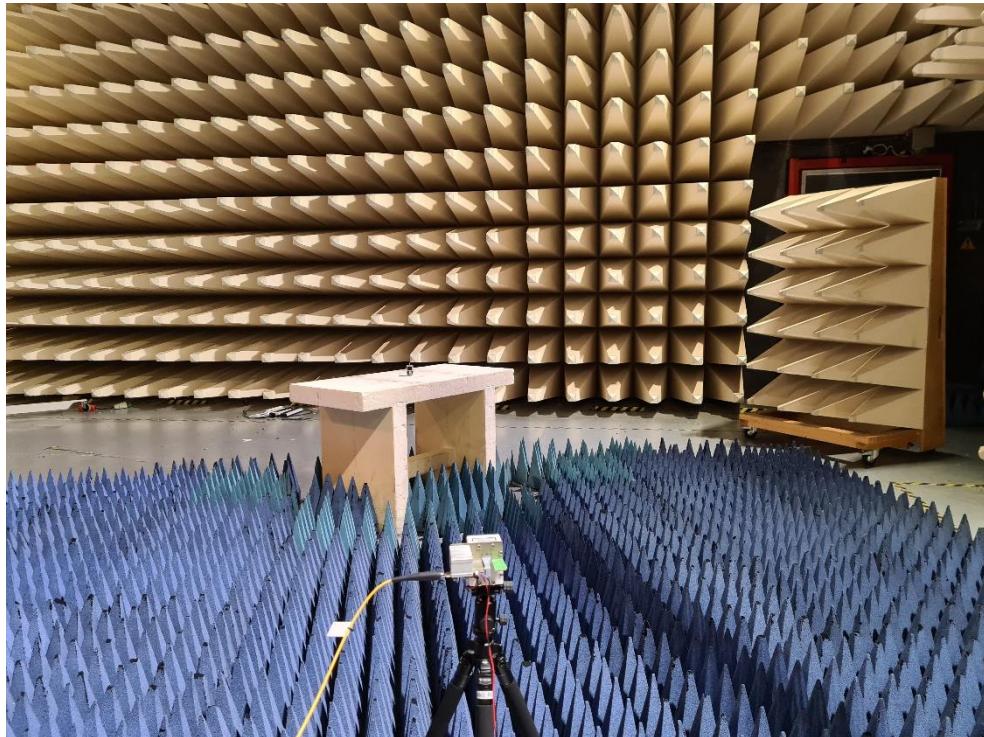




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Test setup 18 GHz – 25 GHz:



5.3.3 Applicable standard

According to FCC Part 15C, Section 15.249 (d):

Emission radiated outside of the specified frequency bands, except harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated limit in FCC Part 15C, Section 15.209, whichever is the lesser attenuation.



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5.3.4 Description of Measurement

The radiated emissions from the EUT are measured in the frequency range of 9 kHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.10, Item 6.3. In the frequency range above 1 GHz a spectrum analyser is used with appropriate linear polarized antennas. If the emission level in peak mode complies with the average limit testing is stopped and peak values will be reported, otherwise, the emission is measured in average mode again and reported. The EUT is measured in TX continuous mode unmodulated under normal conditions.

Instrument settings:

9 kHz – 150 kHz	RBW:	200 Hz
150 kHz - 30 MHz	RBW:	9 kHz
30 MHz – 1000 MHz:	RBW:	120 kHz
1000 MHz – 25 GHz	RBW:	1 MHz

5.3.5 Test result f < 1 GHz

Frequency (MHz)	Reading Vert. (dB μ V)	Reading Hor. (dB μ V)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dB μ V/m)	Level Hor. (dB μ V/m)	Limit (dB μ V/m)	Dlimit (dB)
38.90	6.9	-1.9	13.8	14.8	20.7	12.9	40.0	-19.3
87.70	6.7	12.9	10.7	10.0	17.4	22.9	40.0	-17.1
244.70	2.3	-1.0	15.5	15.4	17.8	14.4	46.0	-28.2
445.50	-2.7	-1.2	21.3	21.7	18.6	20.5	46.0	-25.5
854.00	2.6	-1.8	29.3	29.6	31.9	27.8	46.0	-14.1

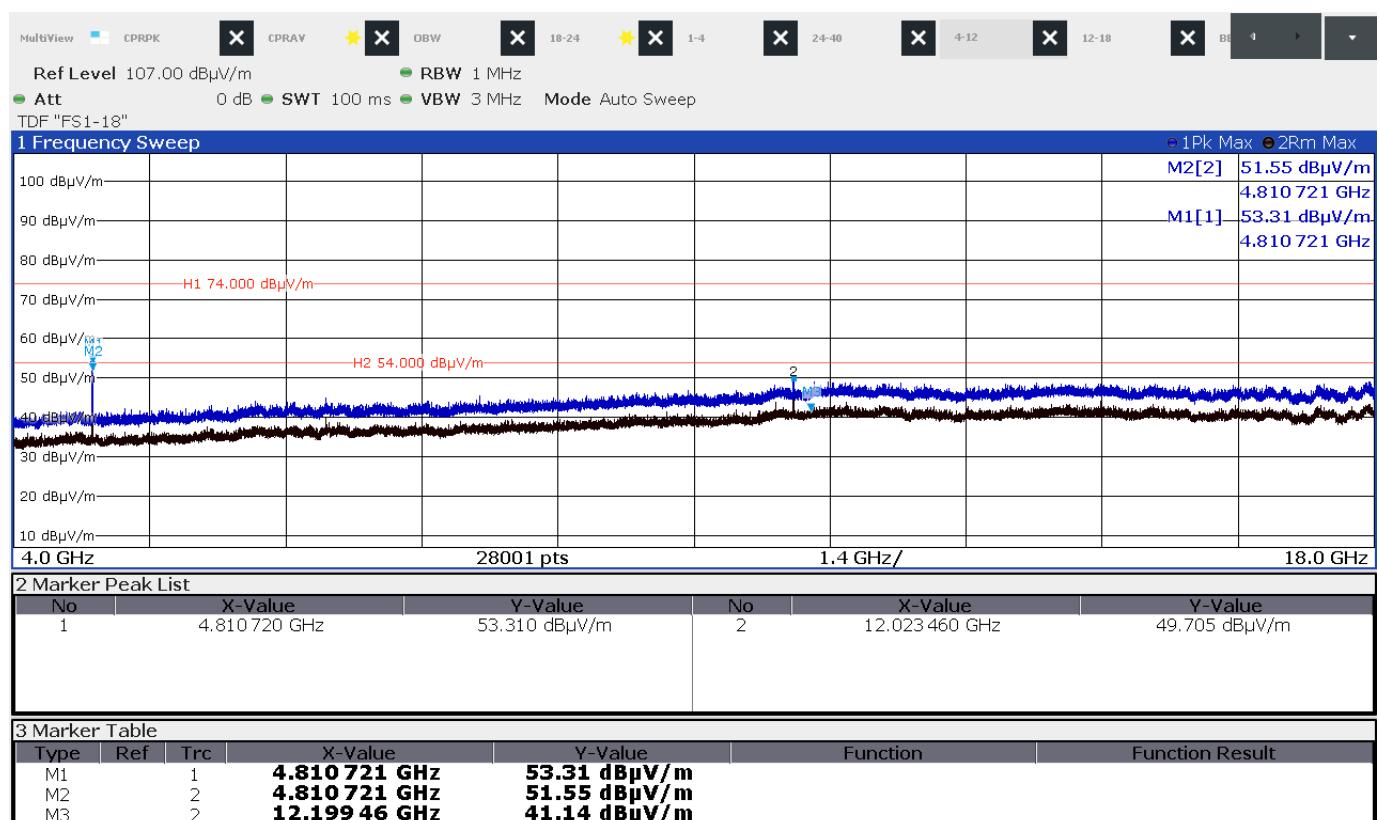
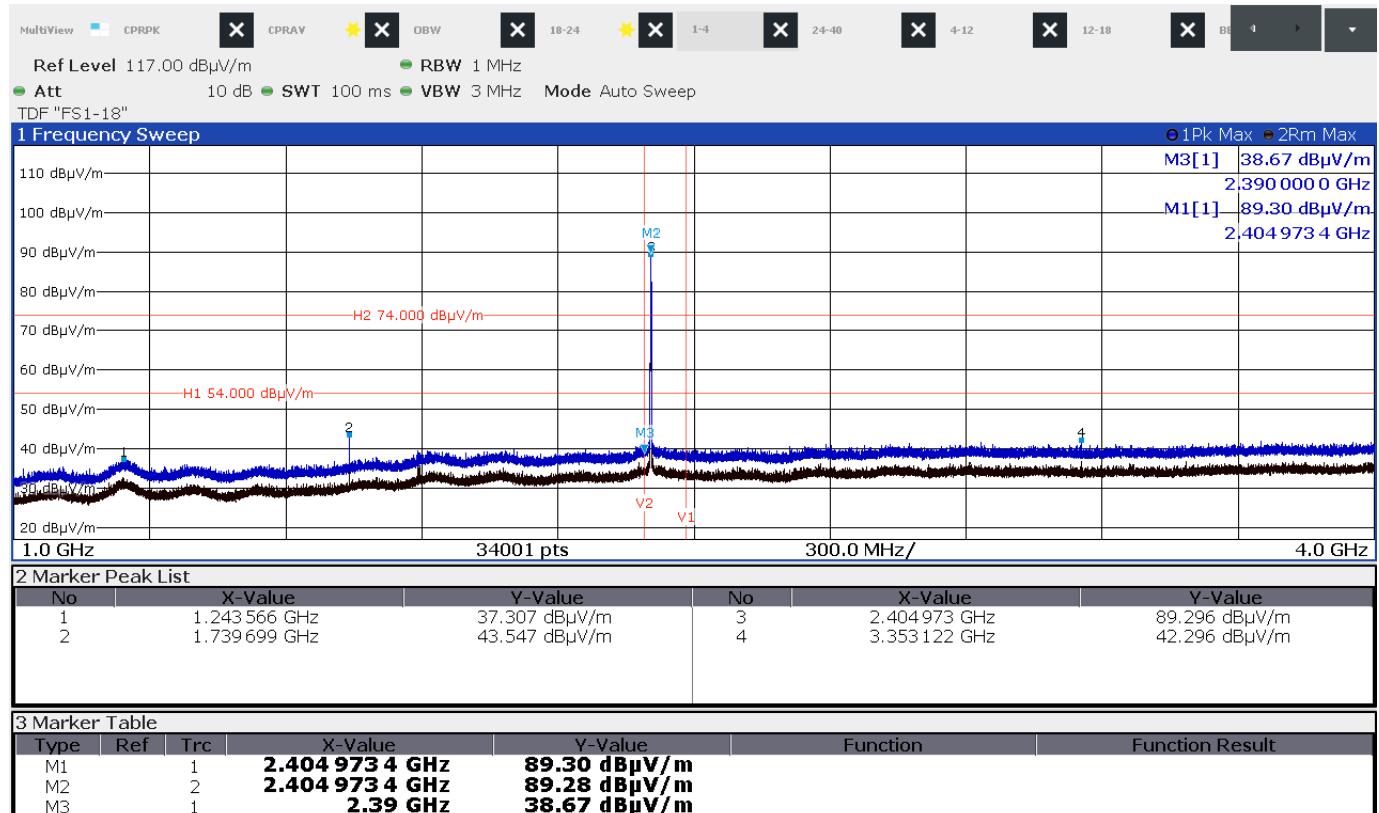


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5.3.6 Test result f > 1 GHz

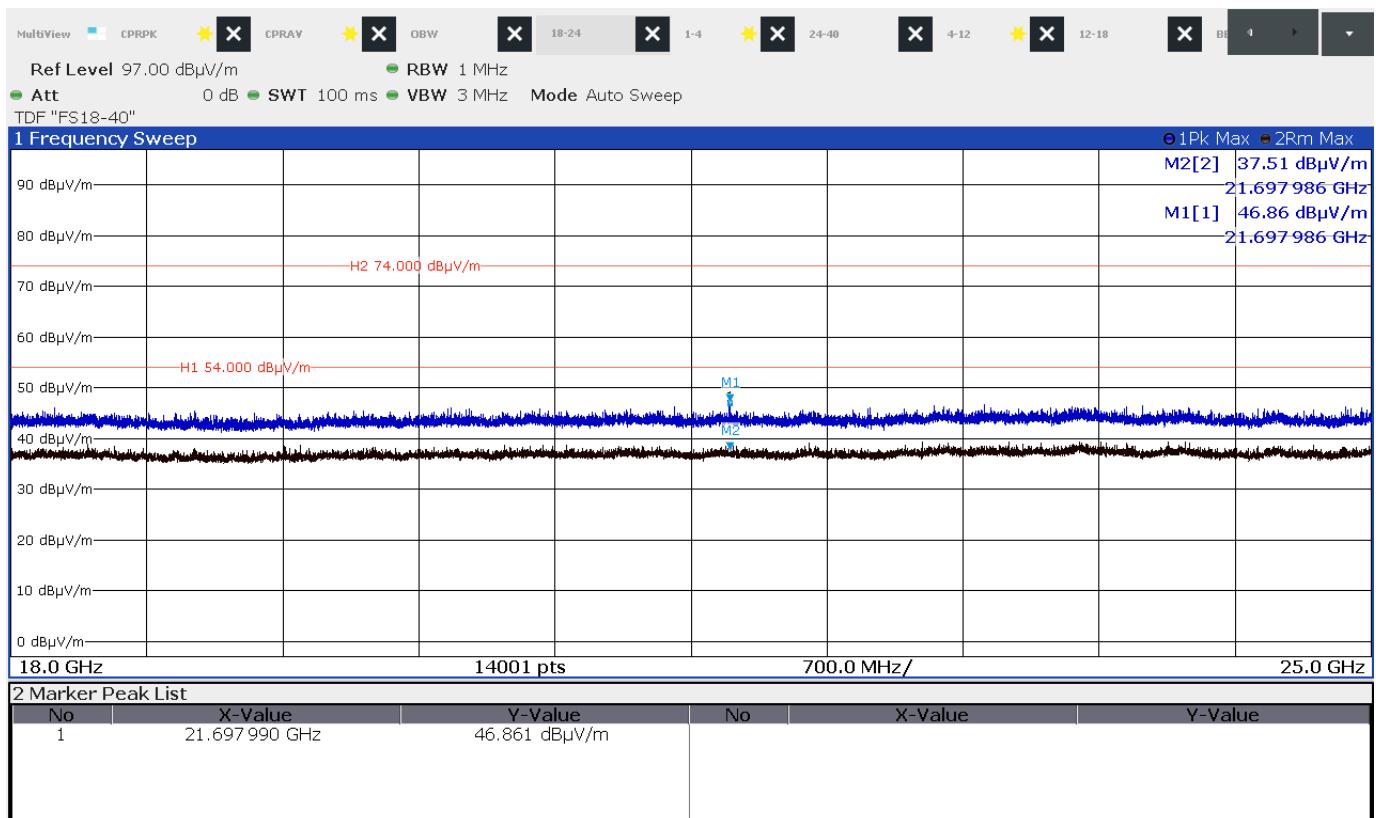
CH0:



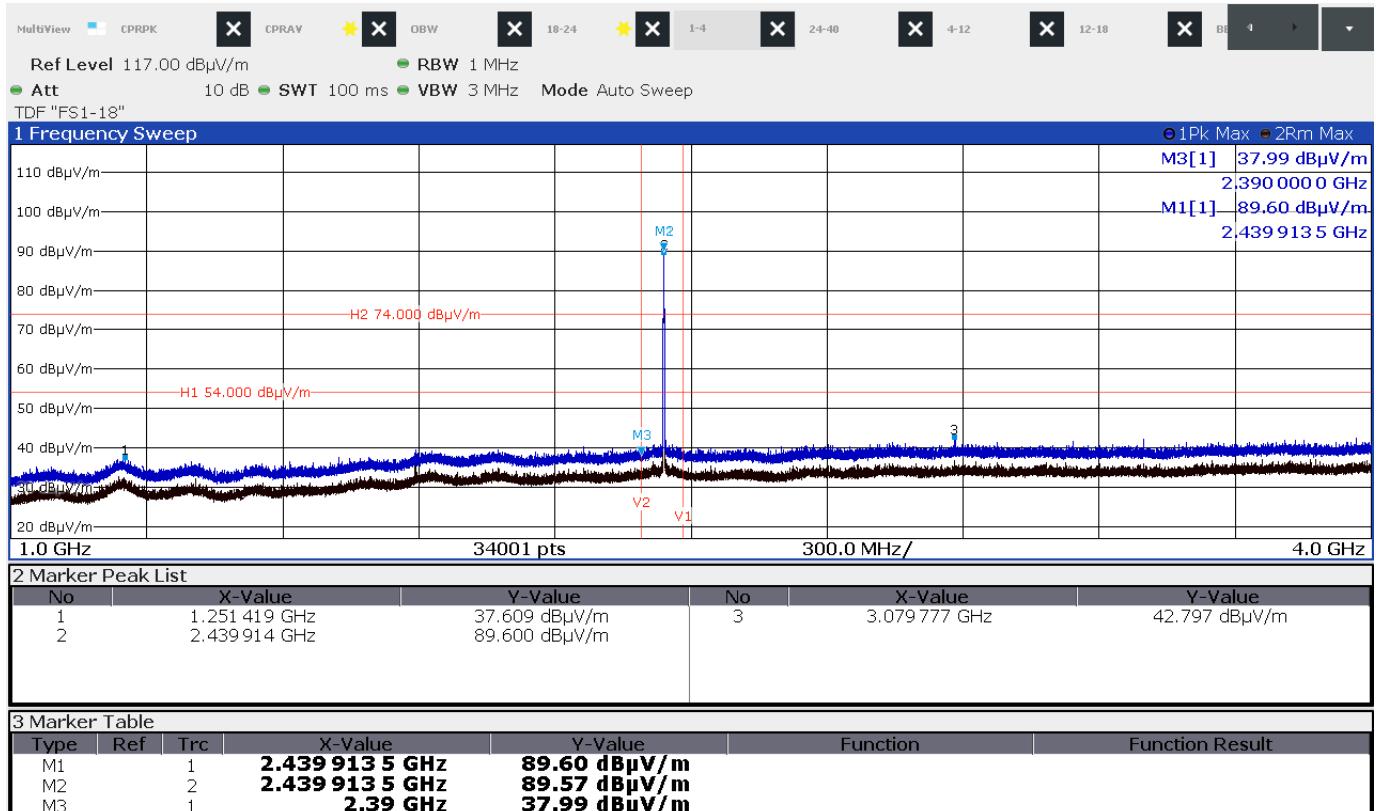


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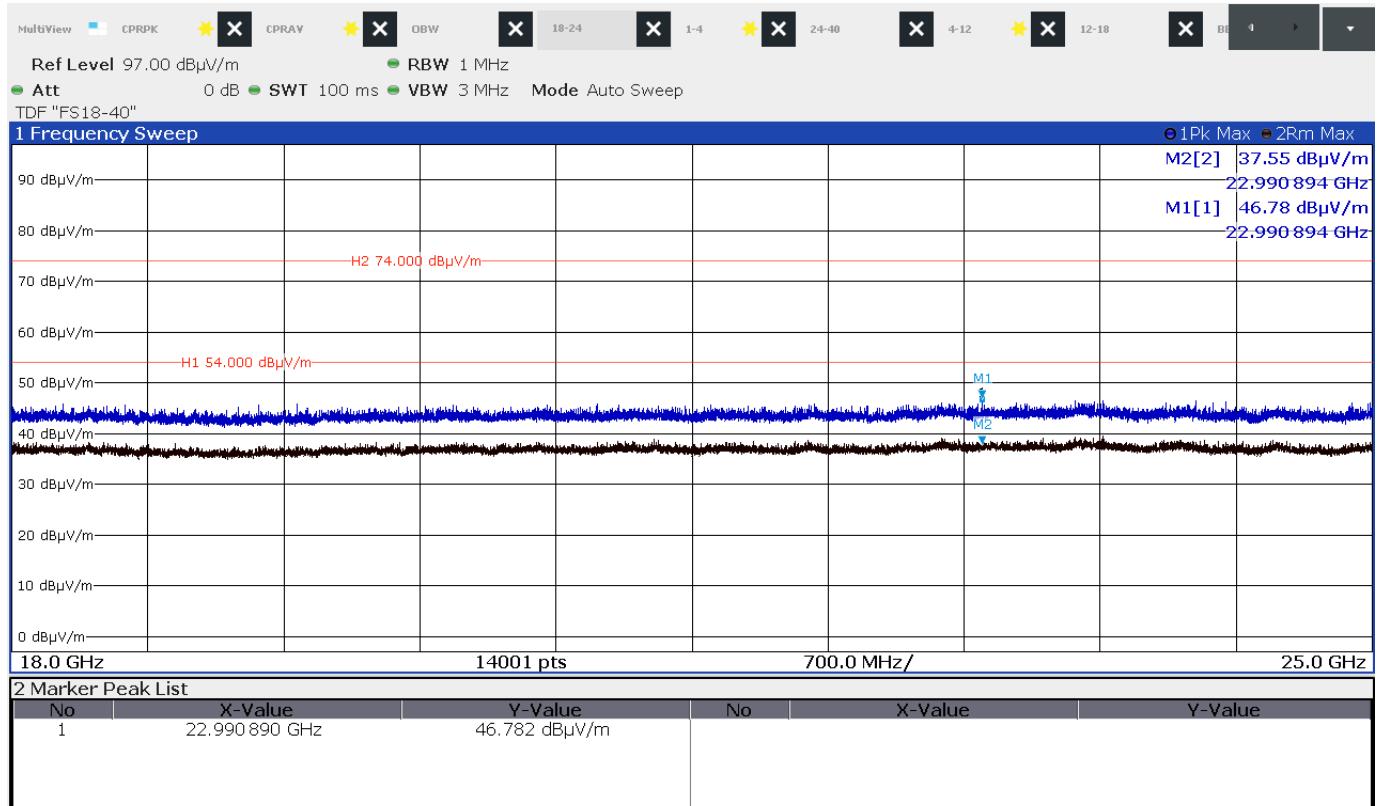
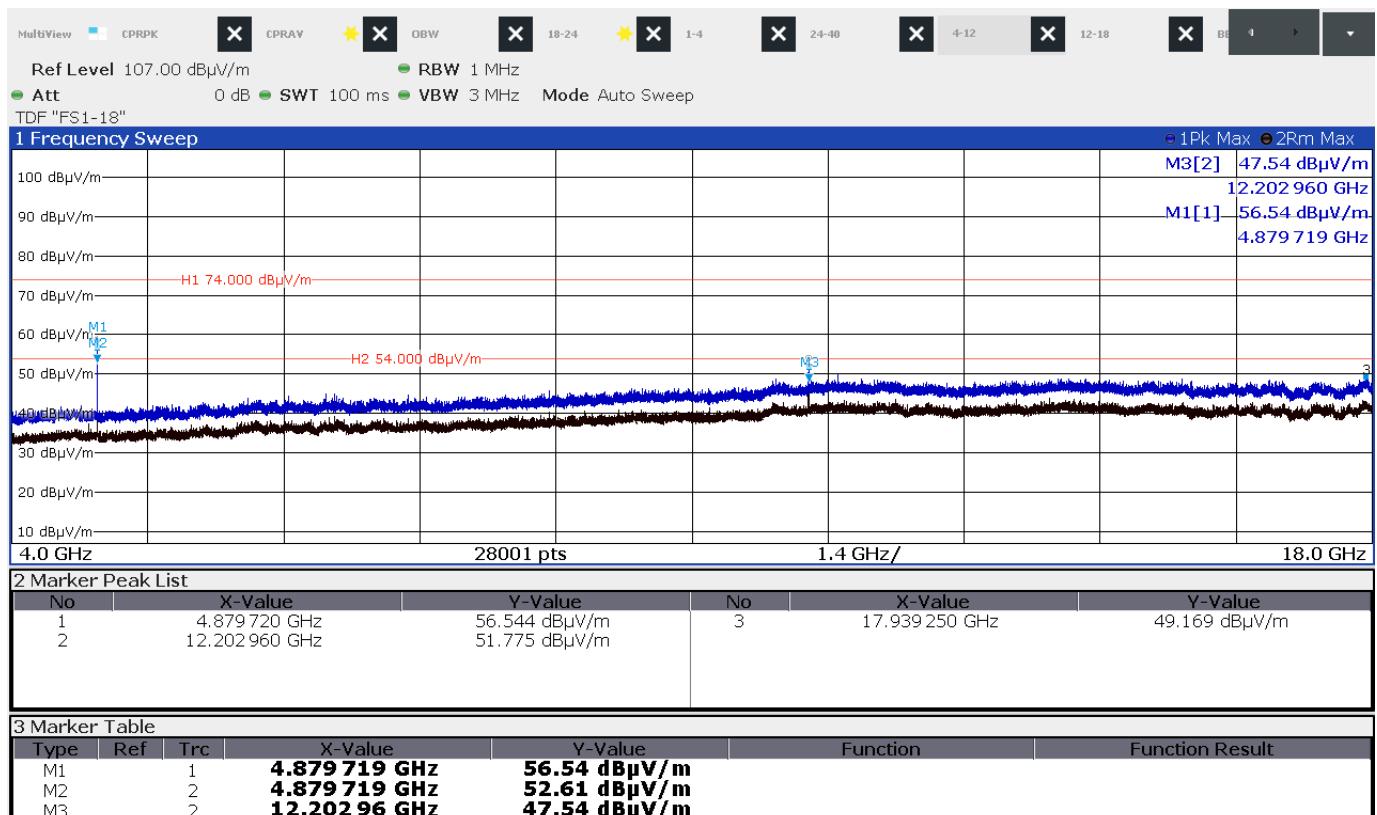
CH7:





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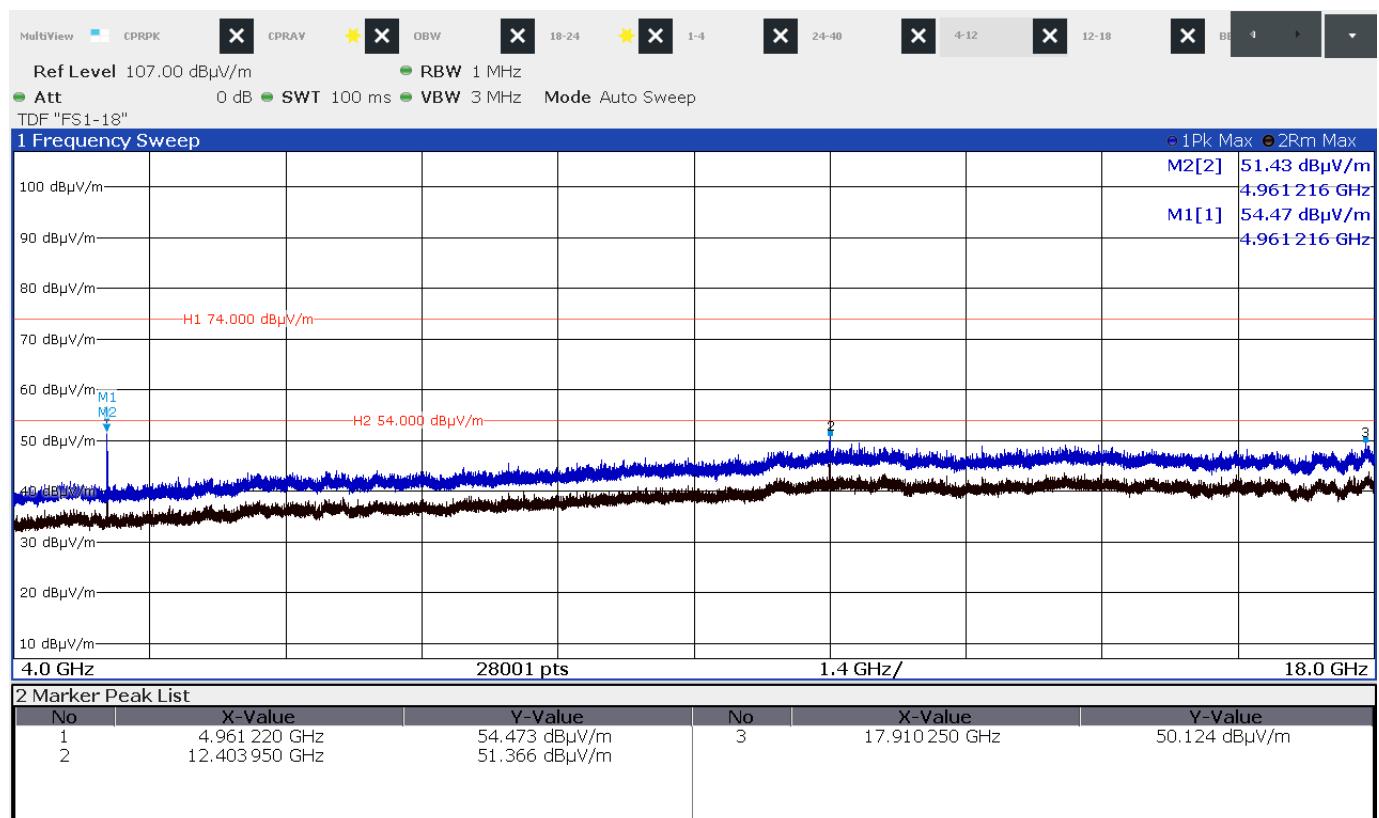
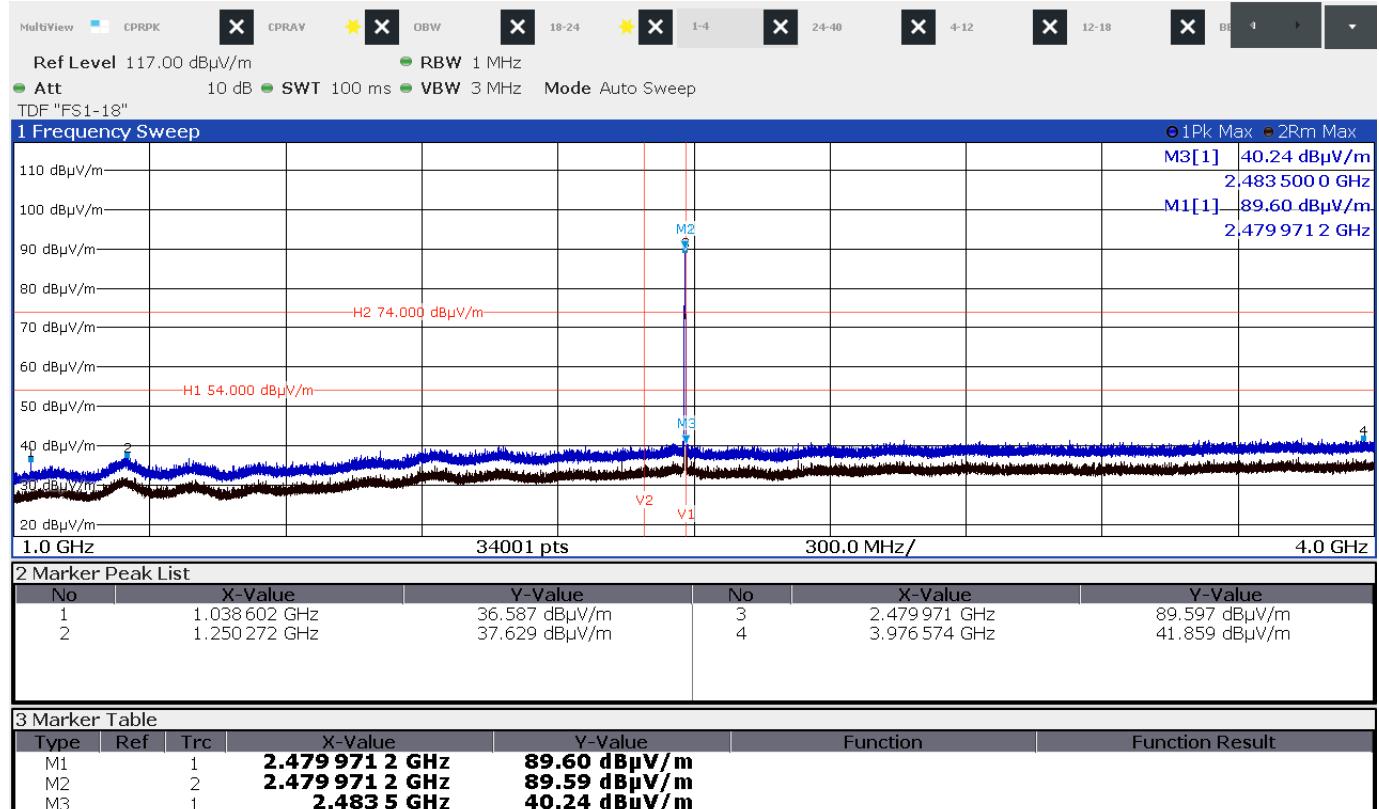




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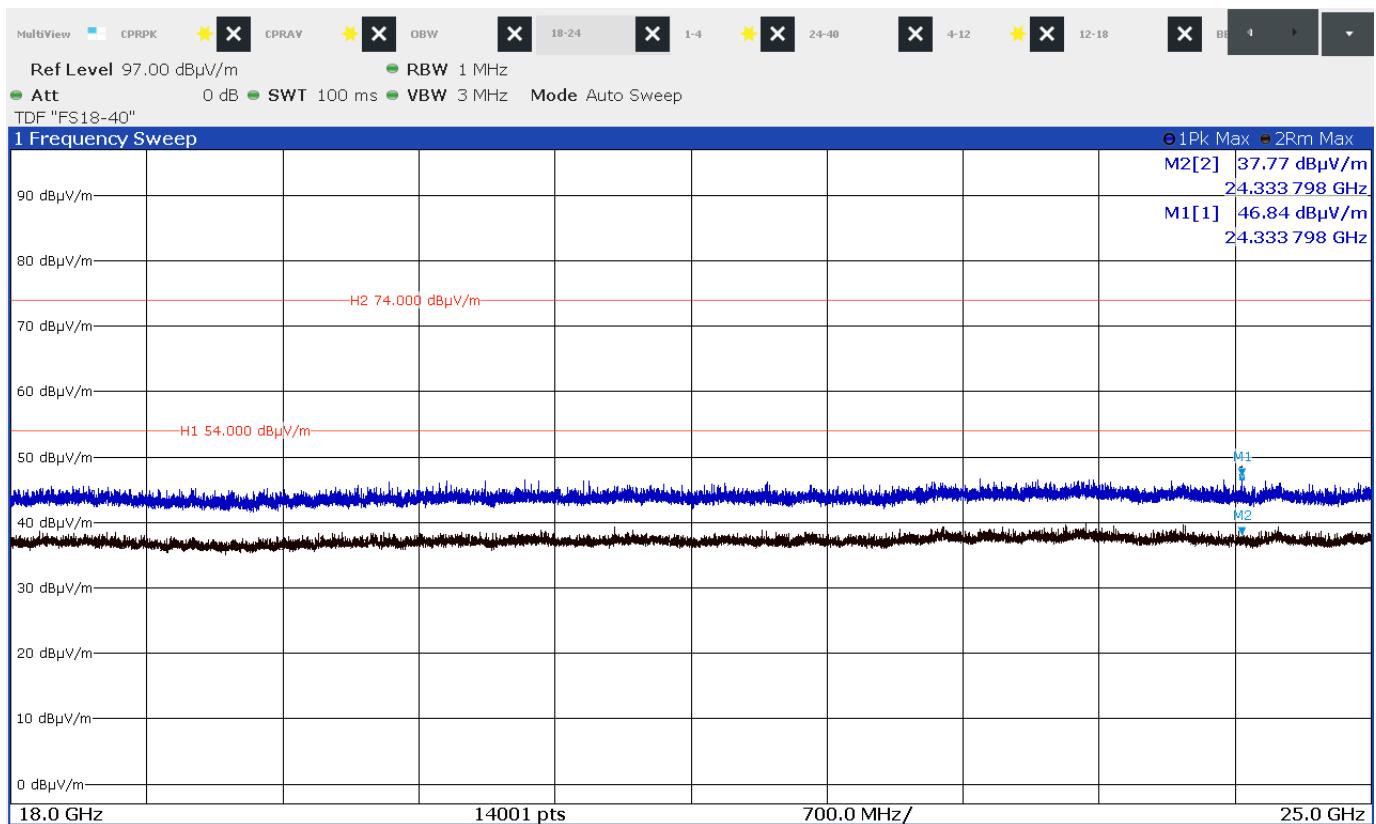
CH15:





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Limit according to FCC Part 15C, Section 15.209:

Frequency (MHz)	15.209 Limits (μV/m)	Measurement distance (m)
0.009 - 0.49	2400/f(kHz)	300
0.49 - 1.705	24000/f(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Average limit according to FCC Part 15C, Section 15.249(a):

Fundamental frequency (MHz)	Field strength of harmonics	
	(μV/m)	dB(μV/m)
902 - 928	500	54
2400 - 2483.5	500	54
5725 - 5875	500	54
24000 - 24250	2500	68

The requirements are **FULFILLED**.

Remarks: The measurement was performed up to the 10th harmonic (25000 MHz). For detailed test result please refer to following test protocols.



FCC ID: YJKTSX6TTX6 IC: 11148A-TSX6TTX6

5.4 Antenna application

5.4.1 Applicable standard

According to FCC Part 15C, Section 15.203(a):

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section.

5.4.2 Result

The EUT use an integrated PCB antenna. No other antenna than that furnished by the responsible party or external power amplifier can be applied by a customer.

The antenna of the EUT meets the requirement of FCC Part 15C, Section 15.203 and 15.204.

The requirements are **FULFILLED**.

Remarks: _____



FCC ID: YJKTSX6TTX6 IC: 11148A-TSX6TTX6

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
CPR 3	FSW43	02-02/11-15-001	06/04/2022	06/04/2021		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	28/06/2022	28/06/2021		
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				
	BAT-EMC 3.20.0.23	02-02/68-13-001				
SER 2	ESVS 30	02-02/03-05-006	09/07/2022	09/07/2021		
	VULB 9168	02-02/24-05-005	18/12/2021	18/12/2020	07/07/2022	07/07/2021
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
SER 3	FSW43	02-02/11-15-001	06/04/2022	06/04/2021		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	LNA-40-18004000-33-5P	02-02/17-20-002				
	3117	02-02/24-05-009	28/06/2022	28/06/2021		
	BBHA 9170	02-02/24-05-013	19/05/2023	19/05/2020	04/02/2022	04/02/2021
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				
	KMS116-GL140SE-KMS116-	02-02/50-20-026				
	BAT-EMC 3.20.0.23	02-02/68-13-001				