FCC PART 90

TEST REPORT

For

Ondas Networks Inc.

165 Gibraltar Court, Sunnyvale, CA 94089, USA

FCC ID: X27-NGWCP-1

Report Type: Original Report		**Product Type:** Remote Station
Prepared By:	Christian McCaig Test Engineer	
Report Number:	R2008317-90	
Report Date:	2021-03-29	
Reviewed By:	Simon Ma RF Supervisor	
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ACCREDITED
CERTIFICATE #3297.02

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2008317-90	Original	2021-03-29

1 General Information

1.1 Product Description for Equipment under Test (EUT)

This test report was prepared on behalf of *Ondas Networks Inc.* and their product model: ATCS-200F-900, FCC ID: X27-NGWCP-1, which will henceforth be referred to as the EUT (Equipment under Test). The EUT is a mobile station and operates in the frequency range of 896.8875-897.9875 MHz.

1.2 Mechanical Description

The EUT measured approximately 22.9 cm (L) x 25.4 cm (W) x 26.9 cm (H) and weighs approximately 8.95 kg.

The test data gathered are from typical production sample with BACL assigned serial number: R2008317-1

1.3 Objective

This report was prepared on behalf of *Ondas Networks Inc.* in accordance with Part 90 Subparts I and S and Part 2 Subpart J of the Federal Communication Commission's rules.

The objective was to determine compliance with FCC rules for RF output power, occupied bandwidth, frequency tolerance, emission limitations at band edges, spurious emissions at antenna terminal and field strength of spurious radiation.

1.4 Related Submittal(s)/Grant(s)

None

1.5 Test Methodology

All tests and measurements indicated in this document were performed in accordance with the Code of Federal Regulations Title 47 Part 90 Subparts I and S and Part 2 Subpart J.

All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory, Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

1.6 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Parameter	Measurement uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.57 dB
Unwanted Emissions, conducted	±1.57dB
All emissions, radiated	±4.0 dB
Temperature	±2 º C
Humidity	±5 %
DC and low frequency voltages	±1.0 %
Time	±2 %
Duty Cycle	±3 %

1.7 Test Facility Registrations

BACLs test facilities that are used to perform Radiated and Conducted Emissions tests are currently recognized by the Federal Communications Commission as Accredited with NIST Designation Number US1129.

BACL's test facilities that are used to perform Radiated and Conducted Emissions tests are currently registered with Industry Canada under Registration Numbers: 3062A-1, 3062A-2, and 3062A-3.

BACL is a Chinese Taipei Bureau of Standards Metrology and Inspection (BSMI) validated Conformity Assessment Body (CAB), under Appendix B, Phase I Procedures of the APEC Mutual Recognition Arrangement (MRA). BACL's BSMI Lab Code Number is: SL2-IN-E-1002R

BACL's test facilities that are used to perform AC Line Conducted Emissions, Telecommunications Line Conducted Emissions, Radiated Emissions from 30 MHz to 1 GHz, and Radiated Emissions from 1 GHz to 6 GHz are currently recognized as Accredited in accordance with the Voluntary Control Council for Interference [VCCI] Article 15 procedures under Registration Number A-0027.

1.8 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

A- ***An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2005 by A2LA (Test Laboratory Accreditation Certificate Number 3297.02),*** in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2005 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025:2005 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

B- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.03)*** to certify

- For the USA (Federal Communications Commission):
  - 1- All Unlicensed radio frequency devices within FCC Scopes A1, A2, A3, and A4;
  - 2- All Licensed radio frequency devices within FCC Scopes B1, B2, B3, and B4;
  - 3- All Telephone Terminal Equipment within FCC Scope C.
- For the Canada (Industry Canada):
  - 1 All Scope 1-Licence-Exempt Radio Frequency Devices;
  - 2 All Scope 2-Licensed Personal Mobile Radio Services;
  - 3 All Scope 3-Licensed General Mobile & Fixed Radio Services;
  - 4 All Scope 4-Licensed Maritime & Aviation Radio Services;
  - 5 All Scope 5-Licensed Fixed Microwave Radio Services
  - 6 All Broadcasting Technical Standards (BETS) in the Category I Equipment Standards List.
- For Singapore (Info-Communications Development Authority (IDA)):
  - 1 All Line Terminal Equipment: All Technical Specifications for Line Terminal Equipment – Table 1 of IDA MRA Recognition Scheme: 2011, Annex 2
  - 2. All Radio-Communication Equipment: All Technical Specifications for Radio-Communication Equipment – Table 2 of IDA MRA Recognition Scheme: 2011, Annex 2
- For the Hong Kong Special Administrative Region:
  - 1 All Radio Equipment, per KHCA 10XX-series Specifications;
  - 2 All GMDSS Marine Radio Equipment, per HKCA 12XX-series Specifications;
  - 3 All Fixed Network Equipment, per HKCA 20XX-series Specifications.
- For Japan:
  - 1 MIC Telecommunication Business Law (Terminal Equipment):
    - All Scope A1 - Terminal Equipment for the Purpose of Calls;
    - All Scope A2 - Other Terminal Equipment
  - 2 Radio Law (Radio Equipment):
    - All Scope B1 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 1 of the Radio Law
    - All Scope B2 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 2 of the Radio Law
    - All Scope B3 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 3 of the Radio Law

C- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.01)*** to certify Products to USA's Environmental Protection Agency (EPA) ENERGY STAR Product Specifications for:

1 Electronics and Office Equipment:
- for Telephony (ver. 3.0)
- for Audio/Video (ver. 3.0)
- for Battery Charging Systems (ver. 1.1)
- for Set-top Boxes & Cable Boxes (ver. 4.1)
- for Televisions (ver. 6.1)
- for Computers (ver. 6.0)
- for Displays (ver. 6.0)
- for Imaging Equipment (ver. 2.0)
- for Computer Servers (ver. 2.0)

2 Commercial Food Service Equipment
- for Commercial Dishwashers (ver. 2.0)
- for Commercial Ice Machines (ver. 2.0)
- for Commercial Ovens (ver. 2.1)
- for Commercial Refrigerators and Freezers

3 Lighting Products
- For Decorative Light Strings (ver. 1.5)
- For Luminaires (including sub-components) and Lamps (ver. 1.2)
- For Compact Fluorescent Lamps (CFLs) (ver. 4.3)
- For Integral LED Lamps (ver. 1.4)

4 Heating, Ventilation, and AC Products
- for Residential Ceiling Fans (ver. 3.0)
- for Residential Ventilating Fans (ver. 3.2)

5 Other
- For Water Coolers (ver. 3.0)

D- ***A NIST Designated Phase-I and Phase-II Conformity Assessment Body (CAB) for the following economies and regulatory authorities under the terms of the stated MRAs/Treaties:***

- Australia: ACMA (Australian Communication and Media Authority) – APEC Tel MRA -Phase I;
- Canada: (Innovation, Science and Economic development Canada - ISEDC) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;
- Chinese Taipei (Republic of China – Taiwan):
  - BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
  - NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
  - EMC Directive 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
  - Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
  - Low Voltage Directive (LVD) 2014/35/EU
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA) APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Media Development Authority - IMDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC;
  - Nationally Recognized Test Laboratory (NRTL) – US OSHA
- Vietnam: APEC Tel MRA -Phase I;

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to ANSI C63.26-2015.

2.2 EUT Exercise Software

The test firmware used was Putty, provided by *Ondas Networks*, the software is compliant with the standard requirements being tested against.

Modulation	Frequency (MHz)	Rated Power (dBm)	SW Attenuation Setting	SW Bandwidth Setting	Rated Power (dBm)	SW Attenuation Setting	SW Bandwidth Setting
2FSK	896.8875	45	12	Default	-	-	-
	897.8875	45	12	Default	-	-	-
	897.9875	45	12	Default	-	-	-
QPSK	896.8875	45	12	Default	43	14	615
	897.8875	45	12	Default	43	14	615
	897.9875	45	12	Default	43	14	615
16QAM	896.8875	45	12	Default	43	14	615
	897.8875	45	12	Default	43	14	615
	897.9875	45	12	Default	43	14	615
64QAM	896.8875	45	12	Default	43	14	615
	897.8875	45	12	Default	43	14	615
	897.9875	45	12	Default	43	14	615

2.3 Equipment Modifications

No modifications were made to the EUT.

2.4 Remote Support Equipment List and Details

Manufacturer	Descriptions	Models	Serial Numbers
Lenovo	Laptop	Thinkpad	-

2.5 Power Supply and Line Filters

Manufacturer	Descriptions	Models	Serial Numbers
Meanwell	Power Supply	RS-150-24	-

2.6 Interface Ports and Cabling

Cable Description	Length (m)	From	To
RF cable	< 1	EUT Output	Attenuator Input
RF cable	< 1	Attenuator Output	Spectrum Analyzer
USB A to RJ45 Cable	1	Support Equipment	EUT Input

3 Summary of Test Results

FCC Rules	Description of Tests	Results
§1.1307, §2.1091, §90.223	RF Exposure	Compliant
§2.1046, §90.205(k), §90.635(b)	RF Output Power	Compliant
§2.1049, §90.209	Occupied Bandwidth	Compliant
§2.1053, §90.210	Spurious Radiated Emissions	Compliant
§2.1051, §90.210	Spurious Emissions at Antenna Terminals	Compliant
§90.210	Emission Mask	Compliant
§2.1055, §90.213	Frequency Tolerance	Compliant

4 FCC §1.1307(b) (1), §2.1091 &§90.223 - RF Exposure

4.1 Applicable Standards

FCC §2.1091, (a) Requirements of this section are a consequence of Commission responsibilities under the National Environmental Policy Act to evaluate the environmental significance of its actions. See subpart I of part 1 of this chapter, in particular §1.1307(b).

According to §1.1310 and §2.1091 RF exposure is calculated.

Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*(100)	≤6
3.0-30	1842/f	4.89/f	*($900/f^2$)	<6
30-300	61.4	0.163	1.0	<6
300-1,500			f/300	<6
1,500-100,000			5	<6

Note: f = frequency in MHz
* = Plane-wave equivalent power density

4.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

4.3 Test Results

Maximum average output power at antenna input terminal (dBm):	42.31
Maximum average output power at antenna input terminal (mW):	17021.585
Prediction frequency (MHz):	897.9875
Antenna Gain, maximum (dBi):	-0.56
Maximum Antenna Gain (numeric):	0.88
Prediction distance (cm):	20
Power density of prediction frequency at 20 cm (mW/cm^2):	2.99
FCC MPE limit for controlled exposure at prediction frequency (mW/cm^2):	2.99

The average output power was derived from the maximum tune up power (45.32 dBm) and duty cycle (50%). The average output power = peak output power – 10*log(1/duty cycle)=45.32-3.01=42.31 dBm..

Note: Duty Cycle declared by customer

Results

In order to pass the controlled exposure limit of 2.99 mW/cm^2 with the Output Power being 45.10 dBm, 50% duty cycle, and prediction distance of 20cm, the EUT can have a maximum antenna gain of -0.56 dBi.

5 FCC §2.1046, §90.205(k) & §90.635(b) - RF Output Power

5.1 Applicable Standards

According to FCC §90.635(b), The maximum output power of the transmitter for mobile stations is 100 watts (20dBw).

5.2 Test Procedure

Span > 2 * OBW
RBW > OBW
VBW ≥ 3 * RBW
Sweep = auto
Detector function = peak
Trace = max hold

5.3 Test Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Dates	Calibration Interval
Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2019-11-07	2 years
-	RF Cable	-	-	Each time[1]	N/A
-	30dB Attenuator	-	-	Each time[1]	N/A

Note[1]: Equipment was calibrated for each test.
Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

5.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	32 %
ATM Pressure:	101.4-102 kPa

The testing was performed by Christian McCaig from 2021-01-19 to 2021-01-22 and 2021-03-22 in the RF Site.

5.5 Test Results

45 dBm rated power:

Modulation	Frequency (MHz)	Output Power (dBm)	Output Power (Watts)	≤ Limit (Watts)
2FSK	896.8875	44.98	31.48	100
	897.8875	45.10	32.36	100
	897.9875	45.09	32.28	100
QPSK	896.8875	45.07	32.14	100
	897.8875	45.20	33.11	100
	897.9875	45.31	33.96	100
16QAM	896.8875	45.22	33.27	100
	897.8875	45.23	33.34	100
	897.9875	45.32	34.04	100
64QAM	896.8875	45.07	32.14	100
	897.8875	45.29	33.81	100
	897.9875	45.30	33.88	100

43 dBm rated power:

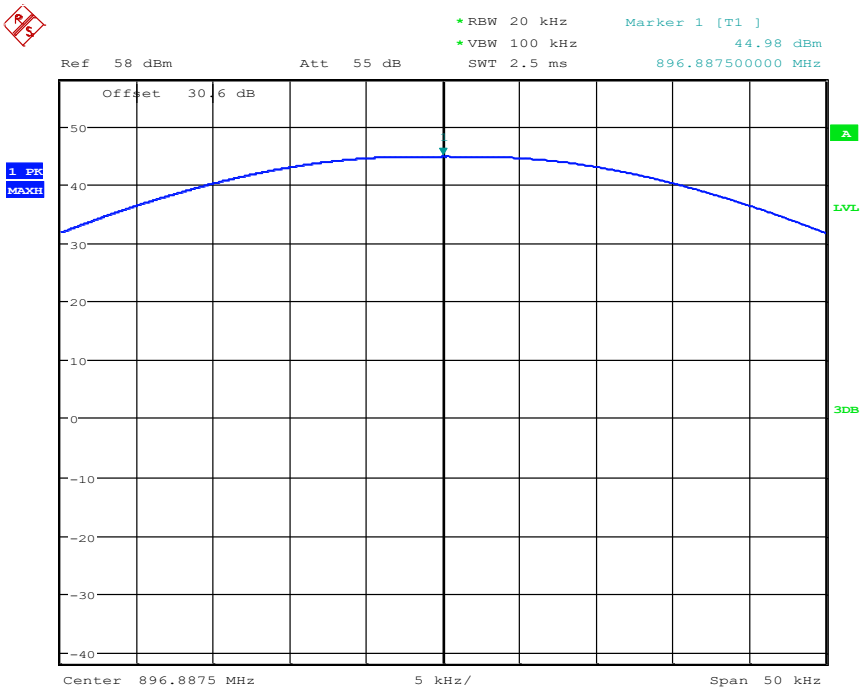
Modulation	Frequency (MHz)	Output Power (dBm)	Output Power (Watts)	≤ Limit (Watts)
QPSK	896.8875	43.00	19.95	100
	897.8875	43.13	20.56	100
	897.9875	43.34	21.58	100
16QAM	896.8875	43.47	22.23	100
	897.8875	43.72	23.55	100
	897.9875	43.76	23.77	100
64QAM	896.8875	43.13	20.56	100
	897.8875	43.28	21.28	100
	897.9875	43.53	22.54	100

Please refer to the following plots.

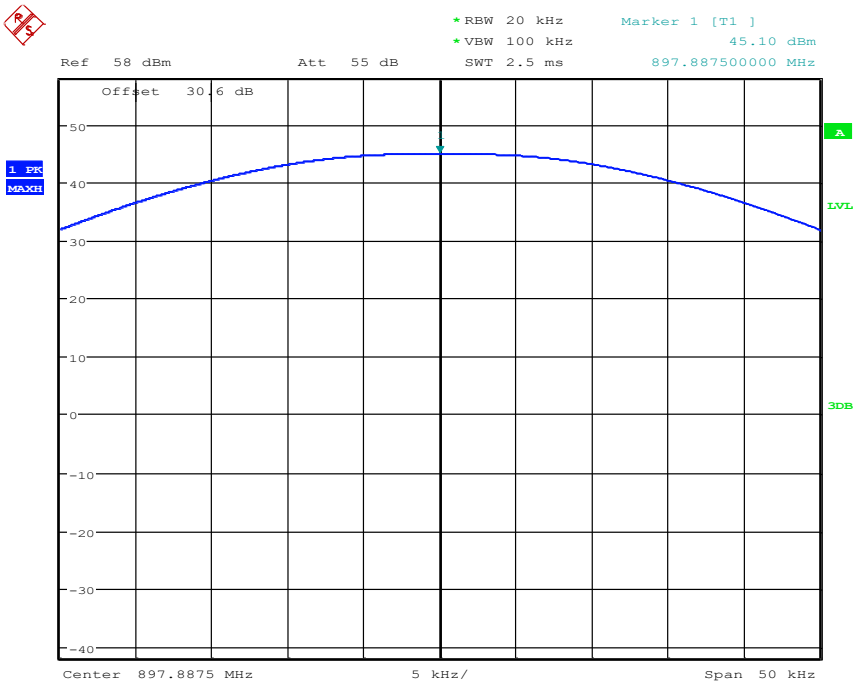
45 dBm rated power:

2FSK

896.8875 MHz



897.8875MHz



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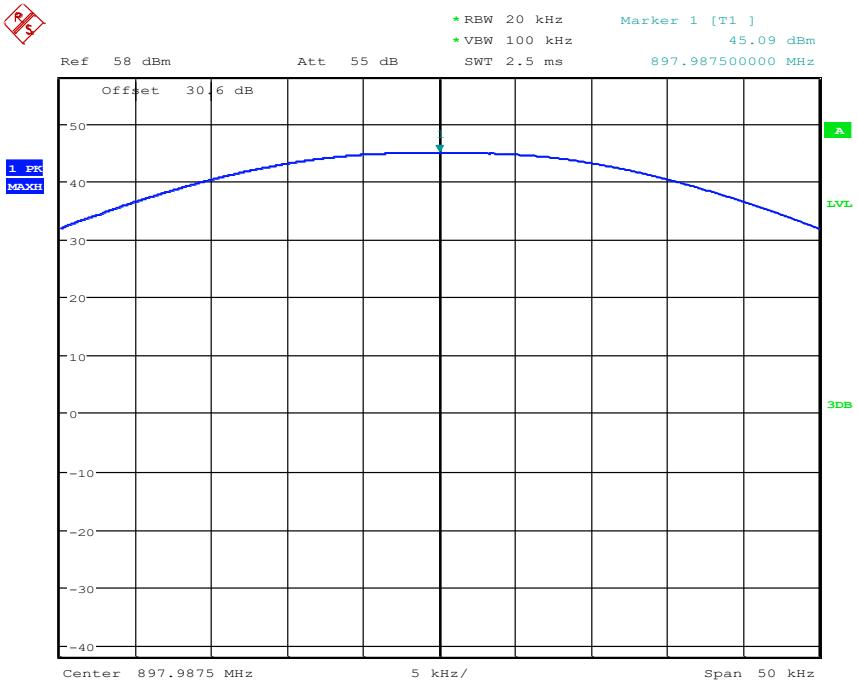
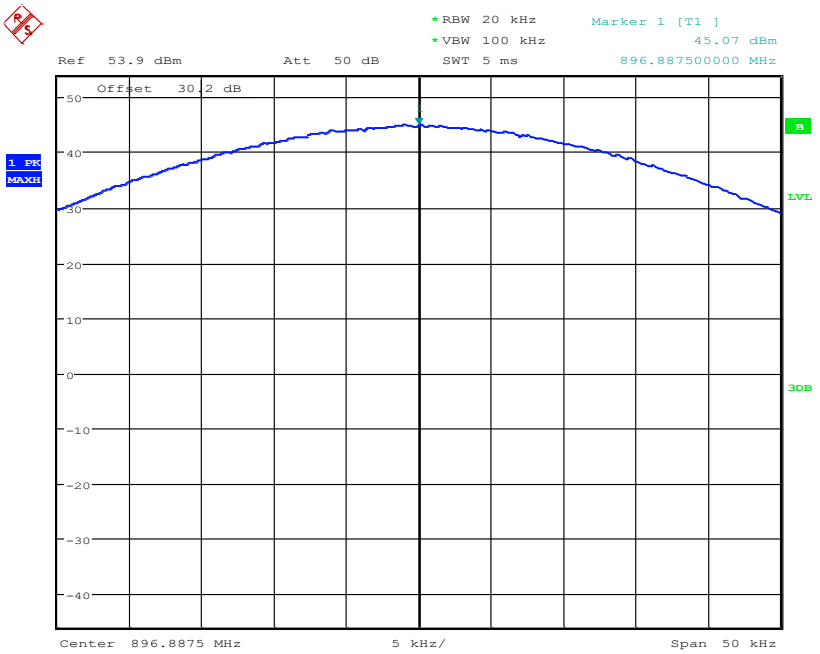


QPSK

896.8875 MHz



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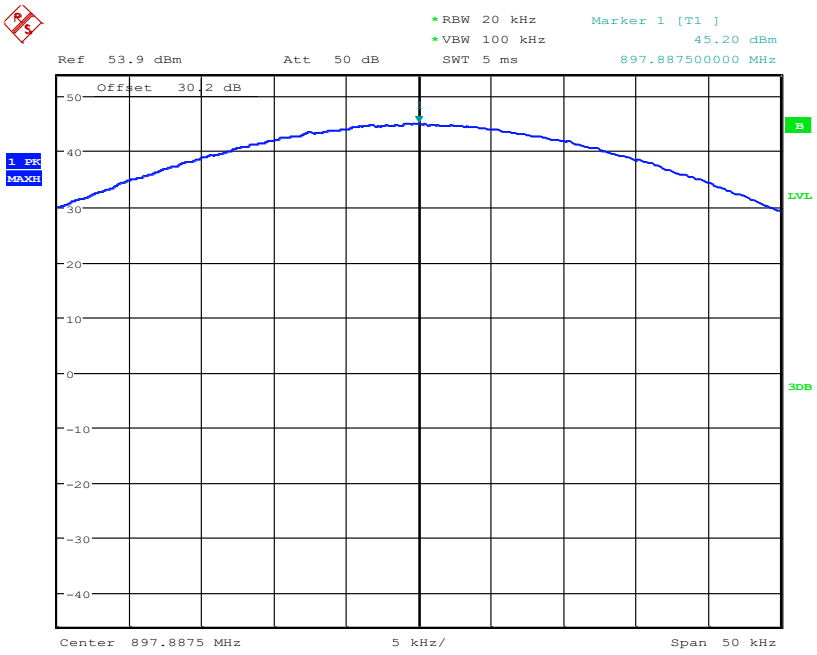

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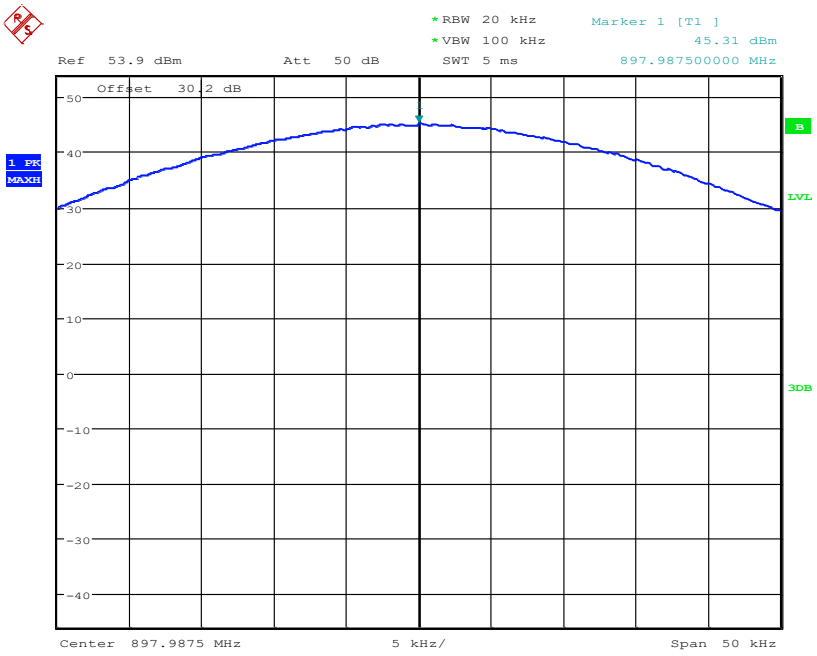

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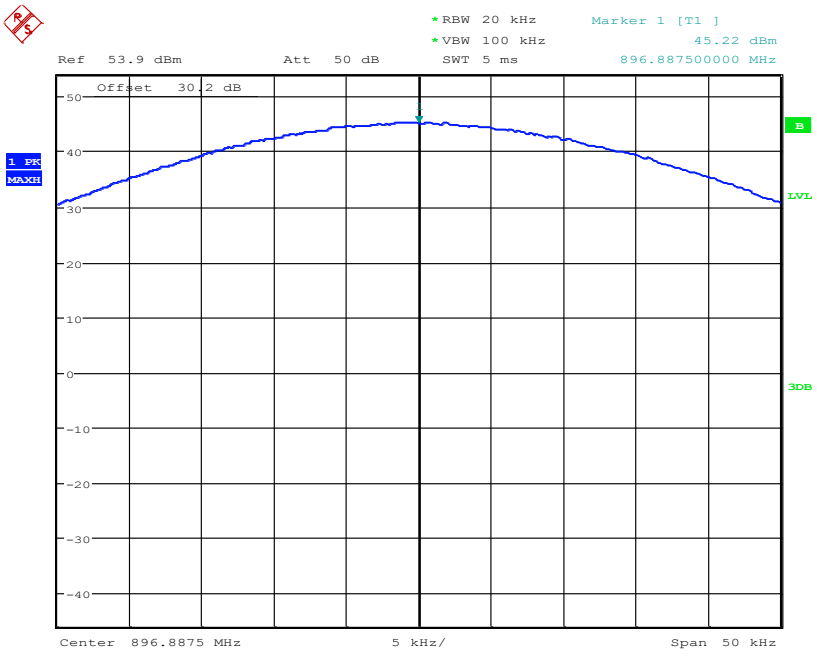
16QAM

896.8875 MHz



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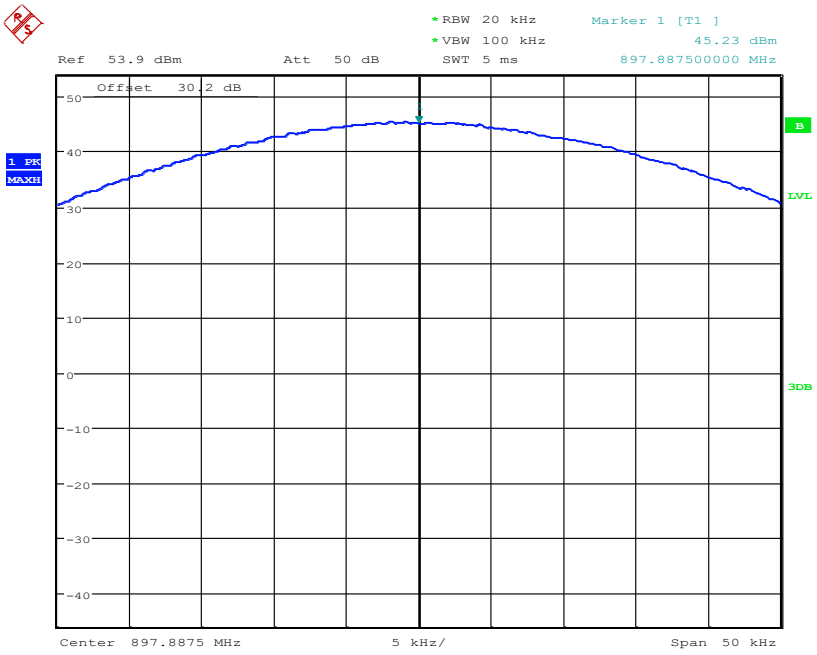

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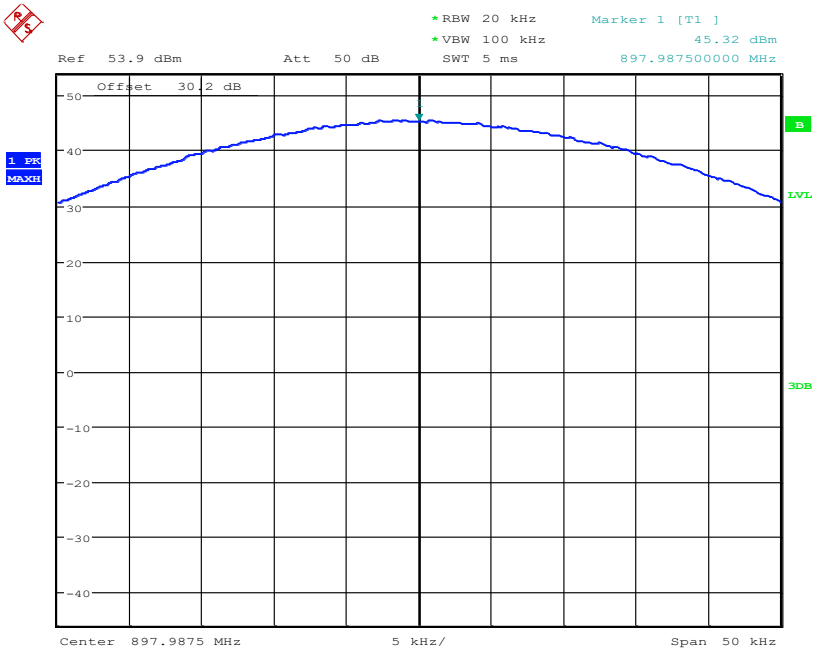

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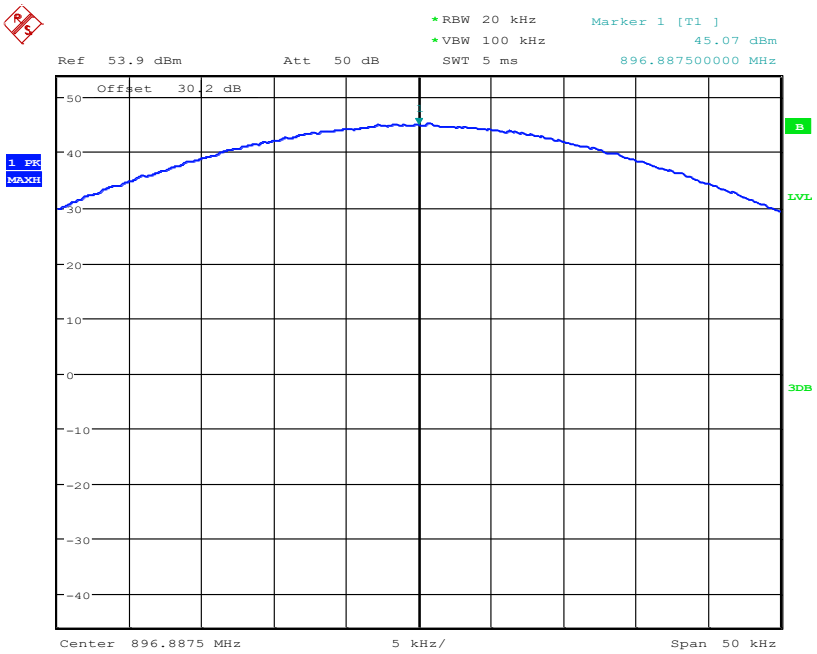
64QAM

896.8875 MHz



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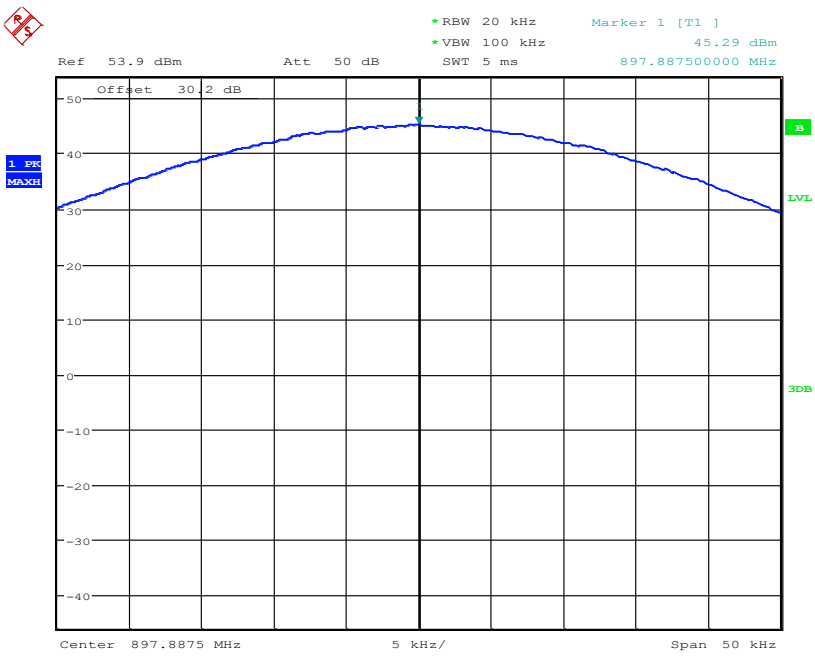

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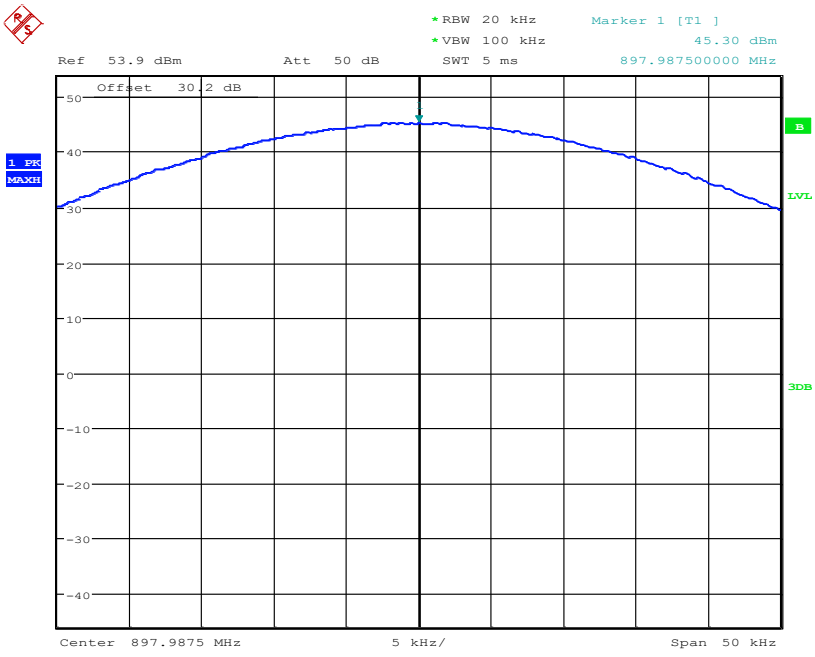

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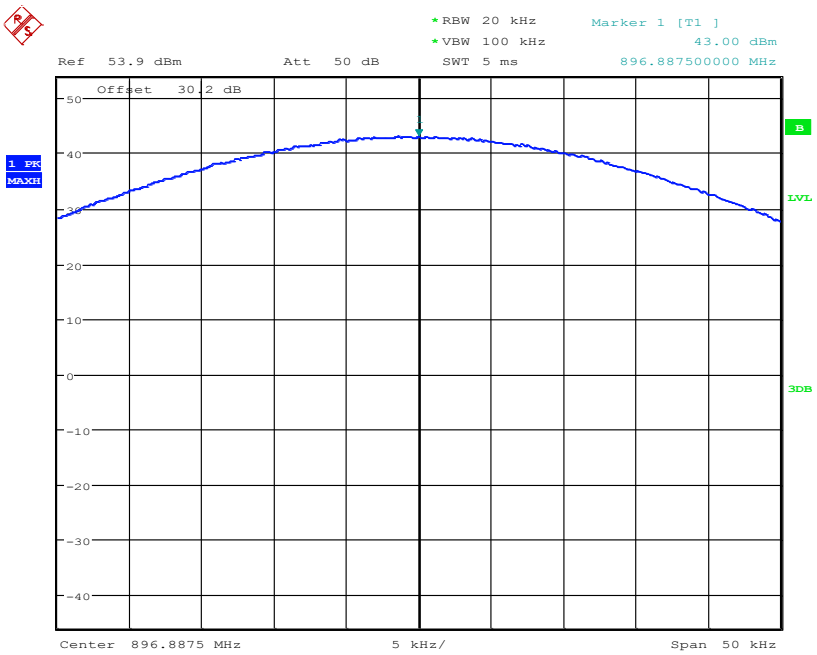
43 dBm rated power:

QPSK

896.8875 MHz



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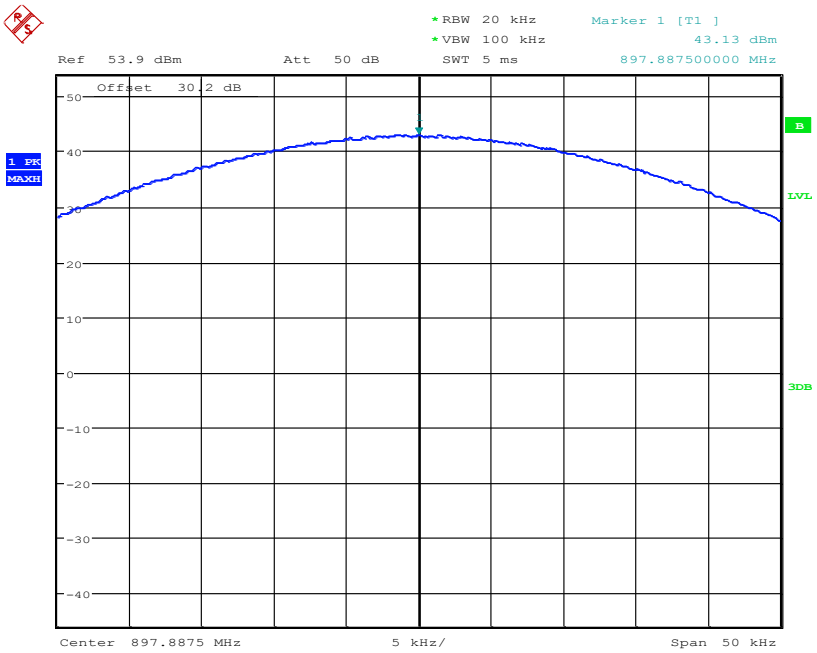

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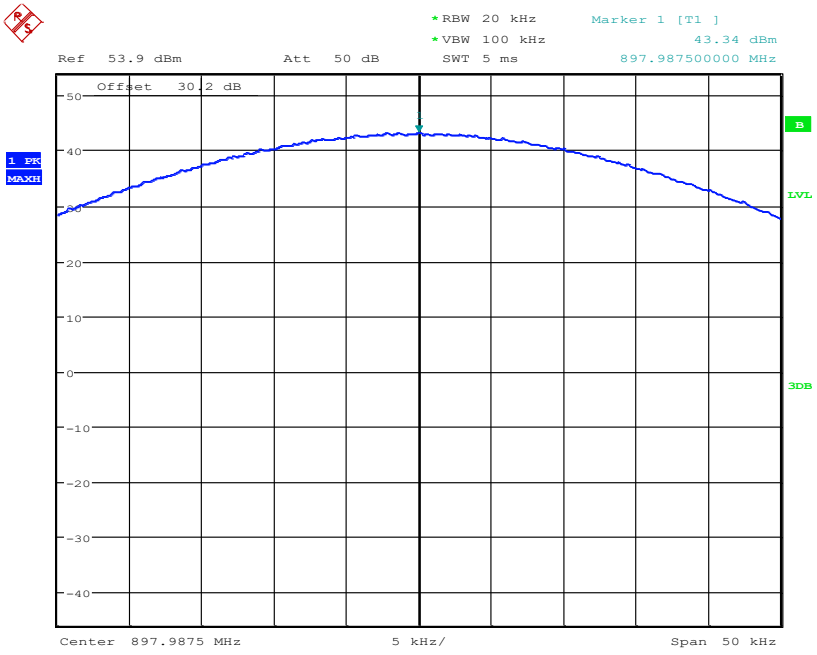

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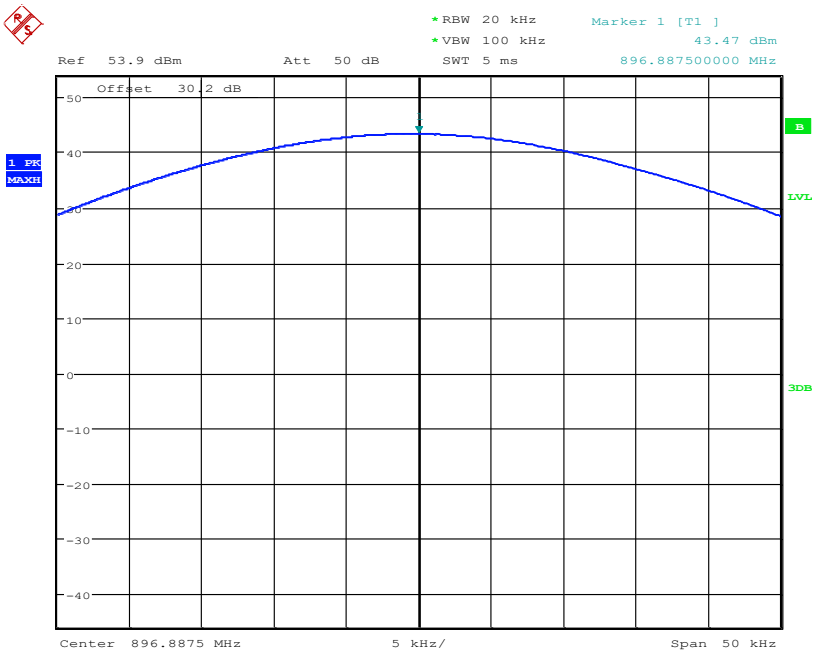
16QAM

896.8875 MHz



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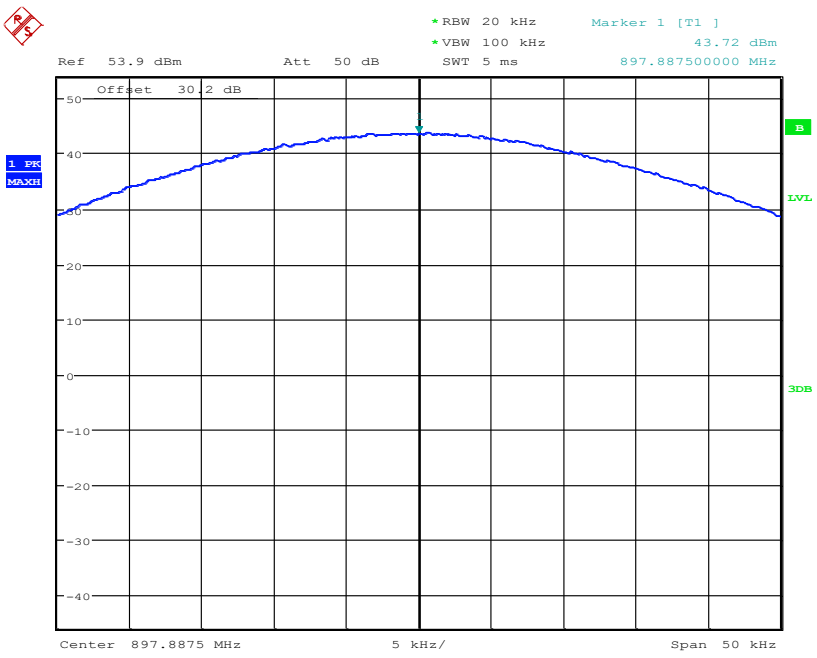

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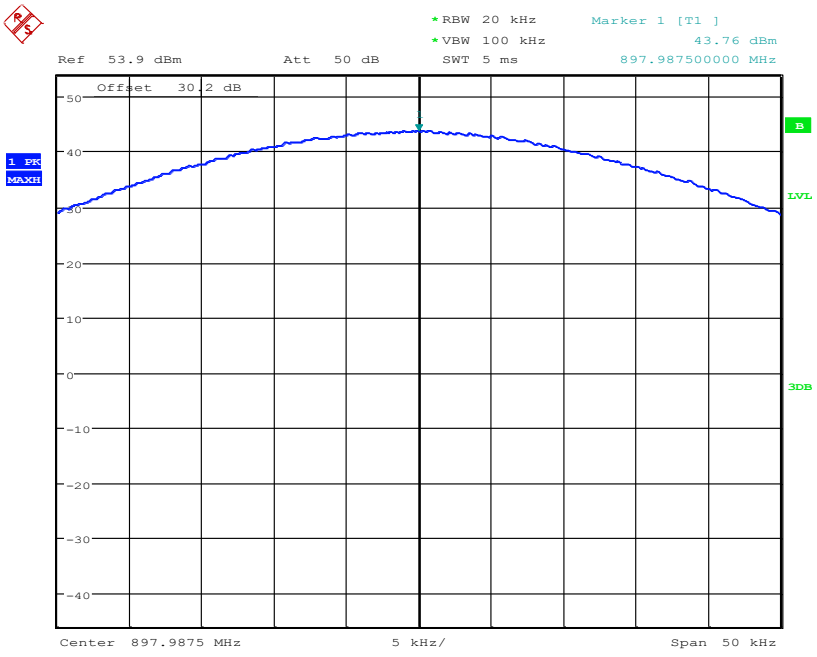

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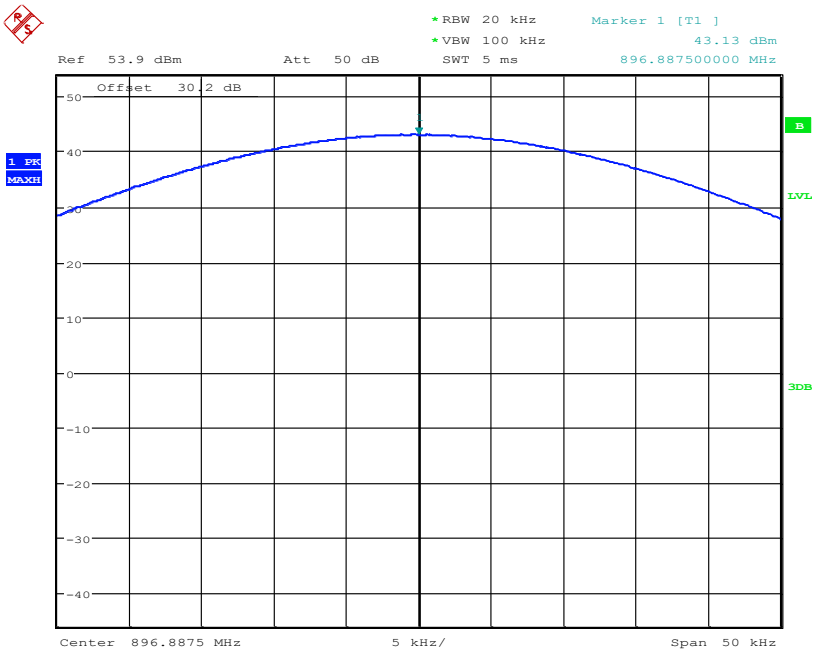
64QAM

896.8875 MHz



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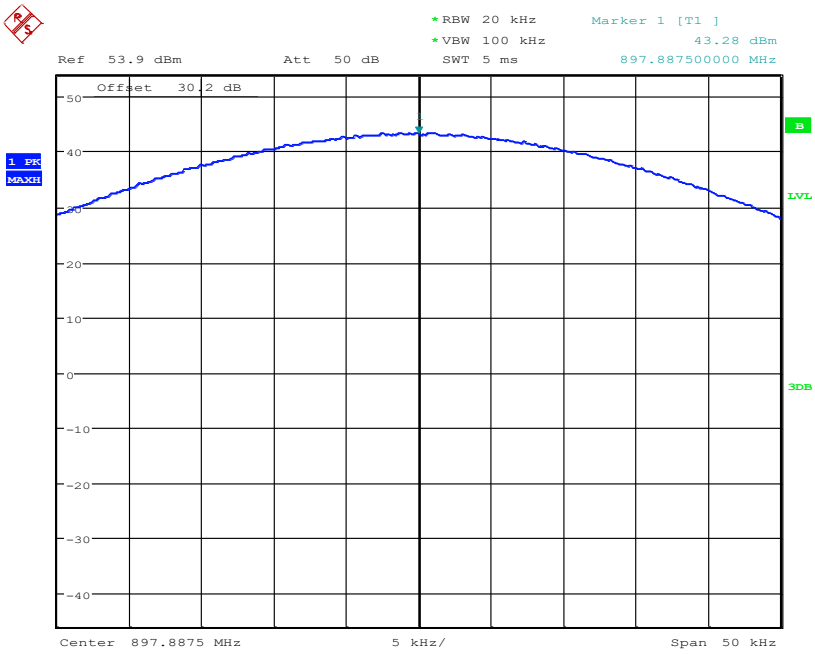

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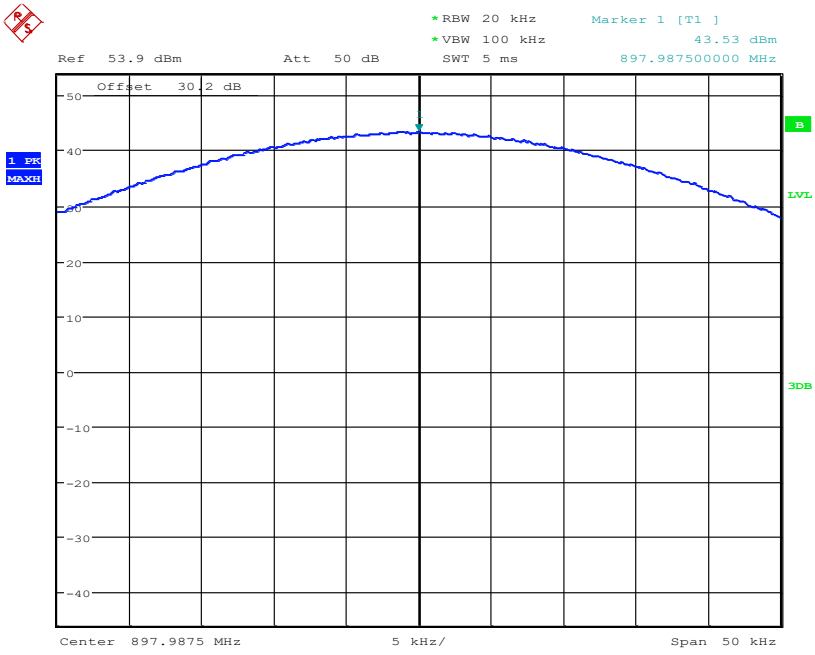

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6 FCC §2.1049 & §90.209 - Occupied Bandwidth

6.1 Applicable Standards

According to FCC §90.209, the authorized bandwidth within the frequency band of 896-901MHz is 13.6 kHz.

6.2 Test Procedure

Span = approximately 2 to 5 times the occupied bandwidth, centered on the transmitting channel
RBW = 1% to 5 % of the occupied bandwidth
VBW = 3 * RBW
Sweep = auto
Detector function = peak
Trace = max hold

6.3 Test Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Dates	Calibration Interval
Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2019-11-07	2 years
-	RF Cable	-	-	Each time[1]	N/A
-	30dB Attenuator	-	-	Each time[1]	N/A

Note[1]: Equipment was calibrated for each test.
Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

6.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	32 %
ATM Pressure:	101.4-102 kPa

The testing was performed by Christian McCaig from 2021-01-19 to 2021-01-22 and 2021-03-22 in the RF Site.

6.5 Test Results

45 dBm rated power:

Modulation	Frequency (MHz)	99% OBW (kHz)	OBW Limit (kHz)
2FSK	896.8875	7.53	< 13.6
	897.8875	7.53	< 13.6
	897.9875	7.53	< 13.6
QPSK	896.8875	8.45	< 13.6
	897.8875	8.45	< 13.6
	897.9875	8.45	< 13.6
16QAM	896.8875	8.50	< 13.6
	897.8875	8.50	< 13.6
	897.9875	8.55	< 13.6
64QAM	896.8875	8.45	< 13.6
	897.8875	8.45	< 13.6
	897.9875	8.40	< 13.6

43 dBm rated power:

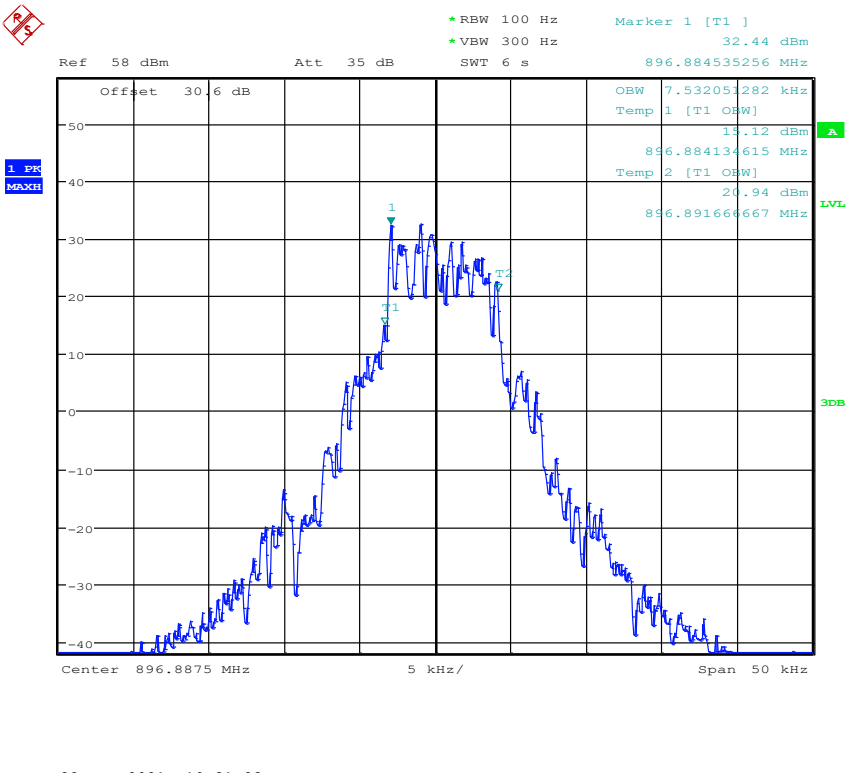
Modulation	Frequency (MHz)	99% OBW (kHz)	OBW Limit (kHz)
QPSK	896.8875	9.95	< 13.6
	897.8875	9.95	< 13.6
	897.9875	9.90	< 13.6
16QAM	896.8875	9.90	< 13.6
	897.8875	9.95	< 13.6
	897.9875	9.95	< 13.6
64QAM	896.8875	9.90	< 13.6
	897.8875	9.95	< 13.6
	897.9875	9.90	< 13.6

Please refer to the following plots.

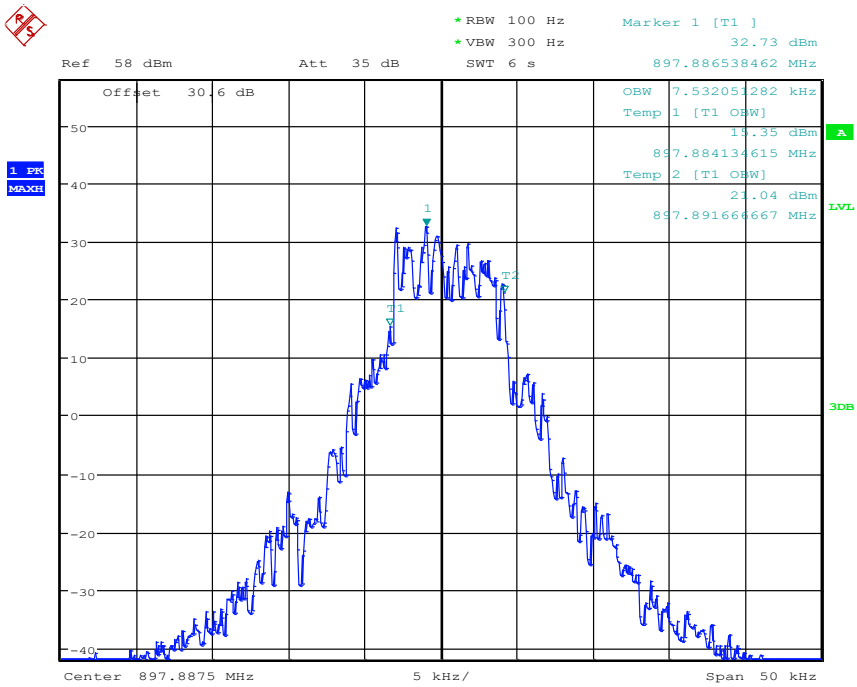
45 dBm rated power:

2FSK

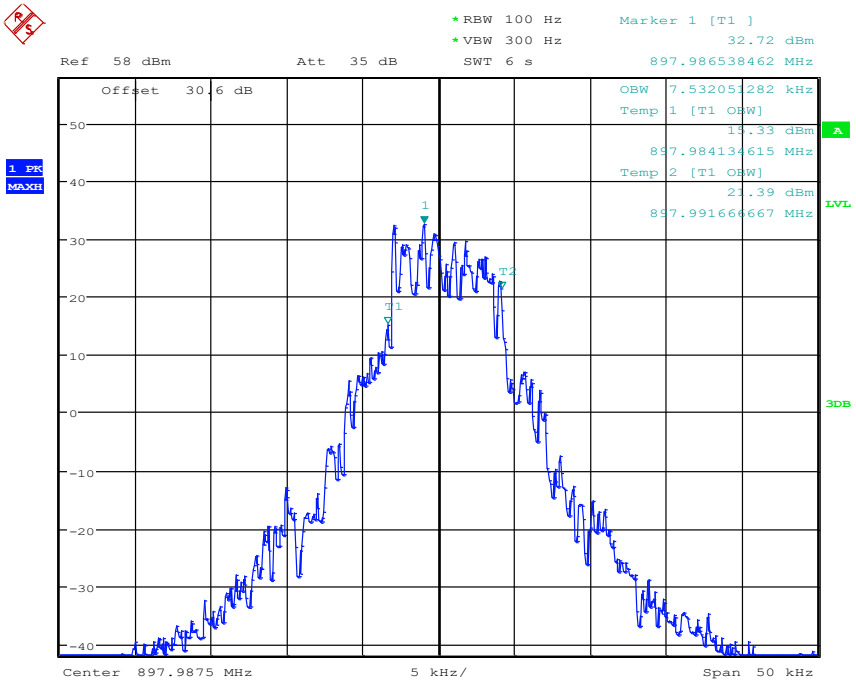
896.8875 MHz



897.8875 MHz

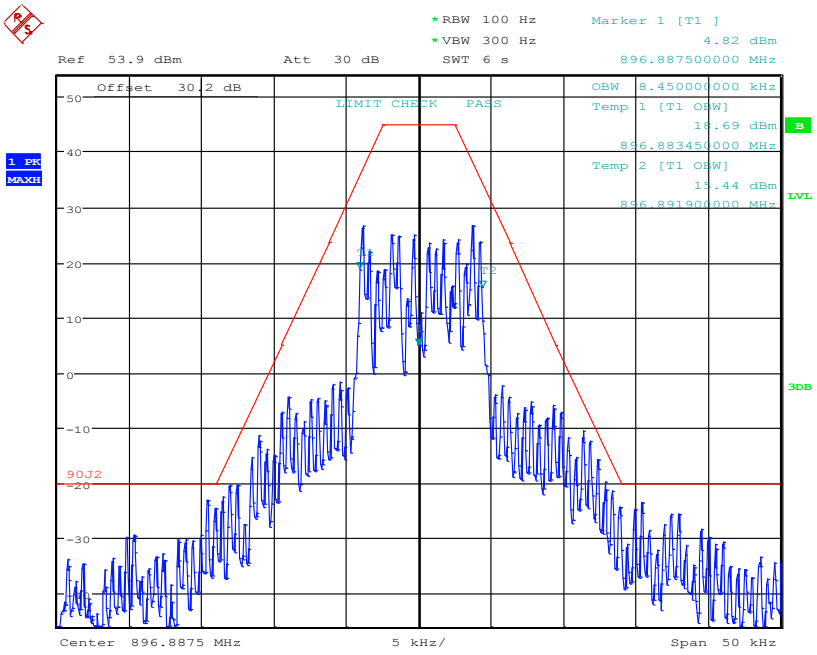


897.9875 MHz



QPSK

896.8875 MHz



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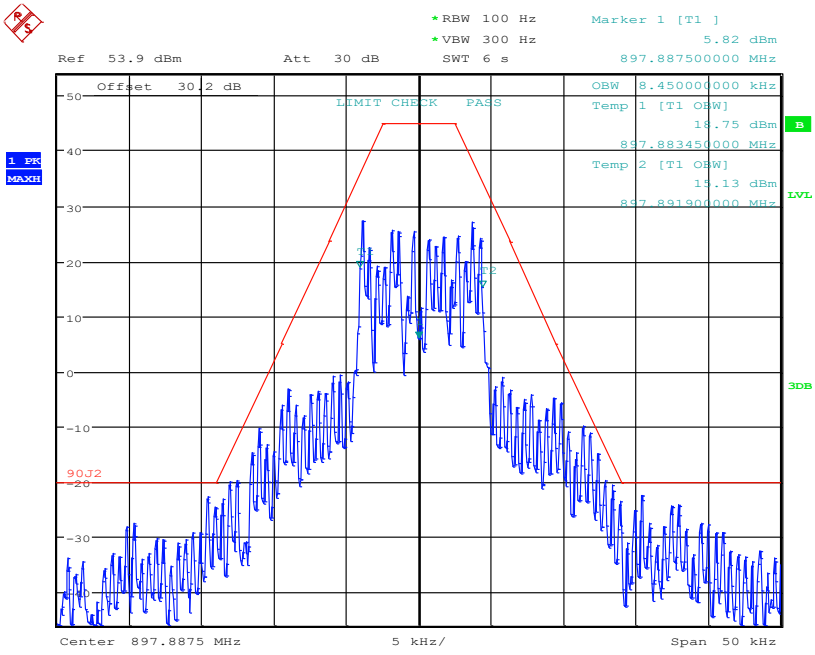
897.8875 MHz



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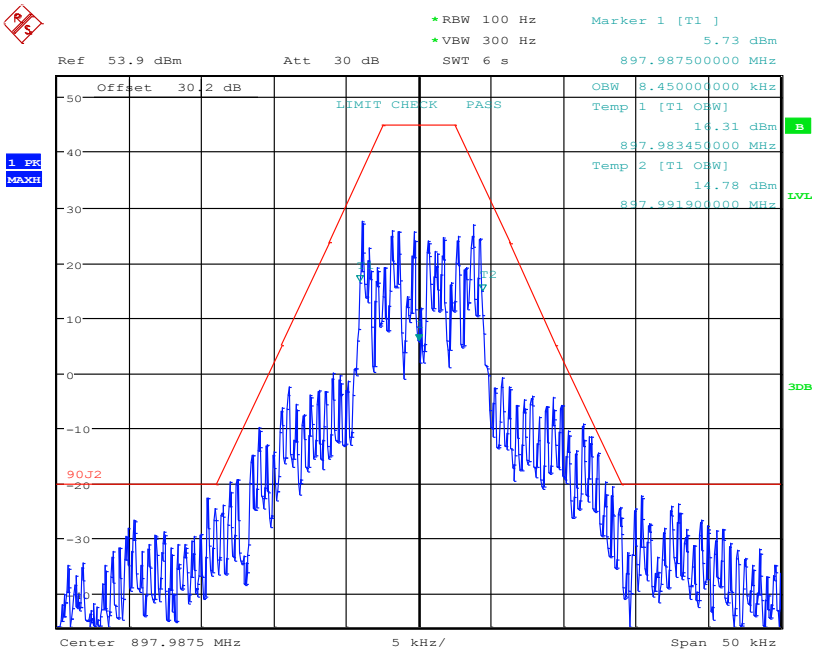
897.9875 MHz



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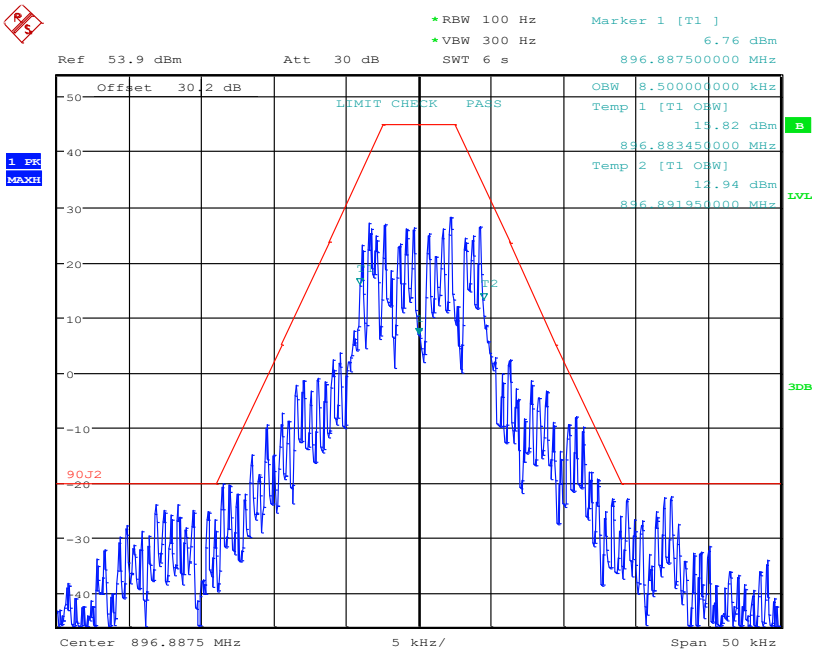
16QAM

896.8875 MHz



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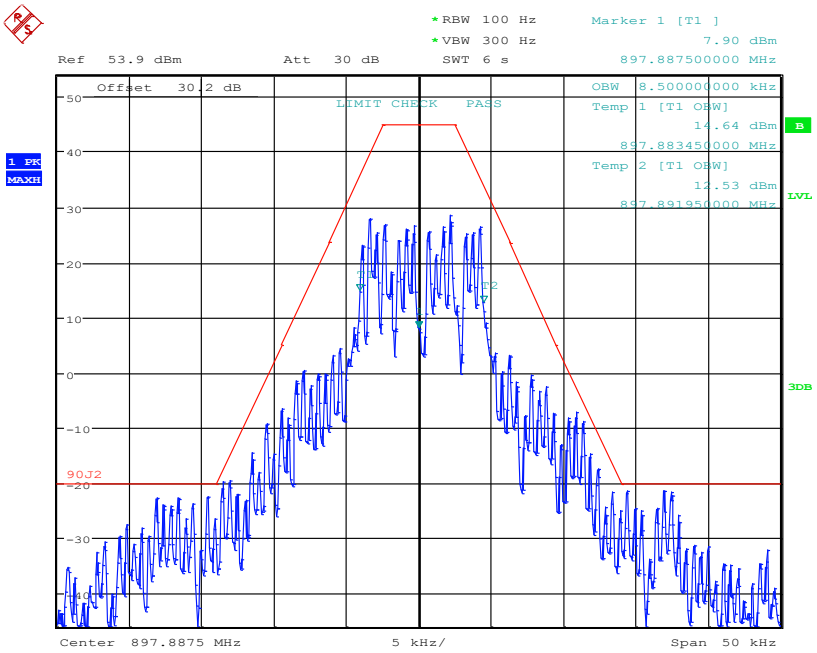
897.8875 MHz



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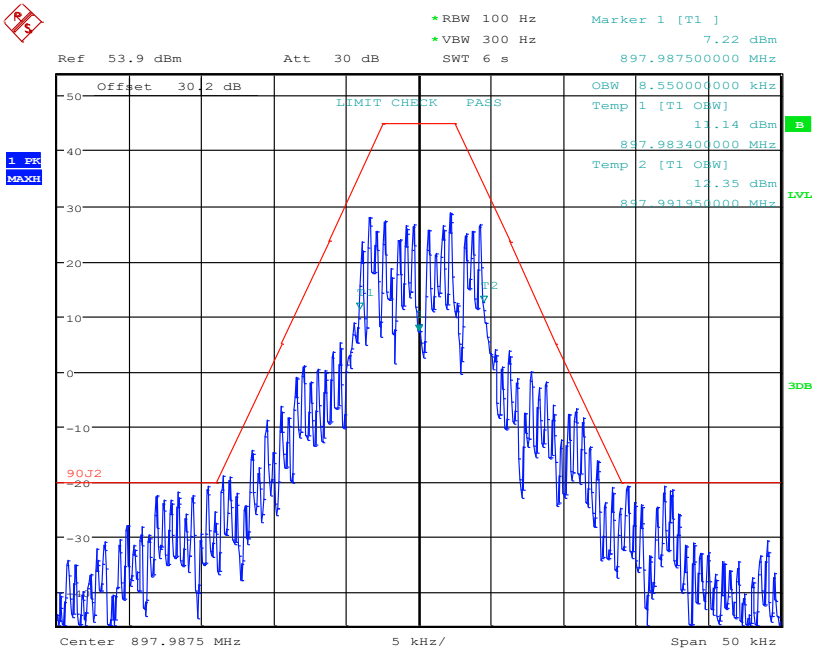

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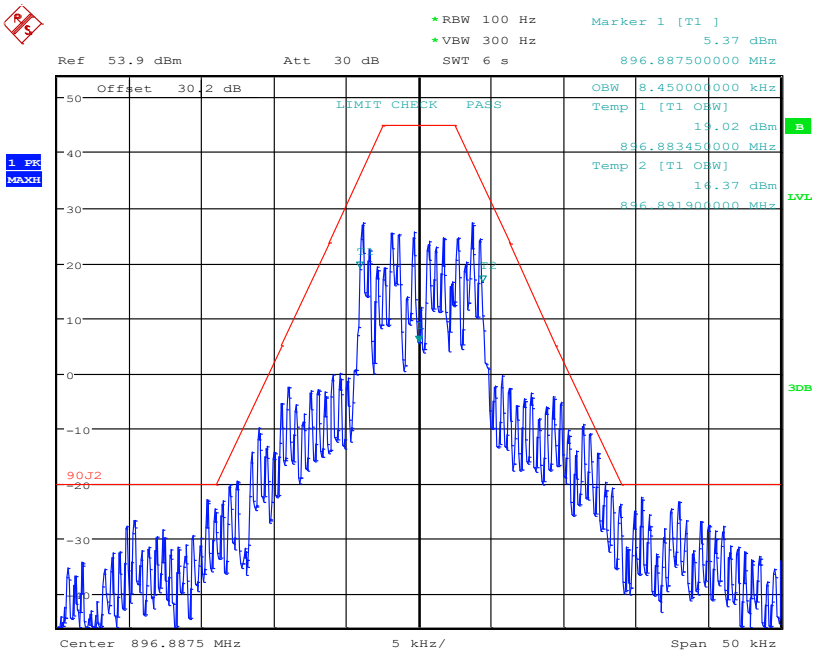
64QAM

896.8875 MHz



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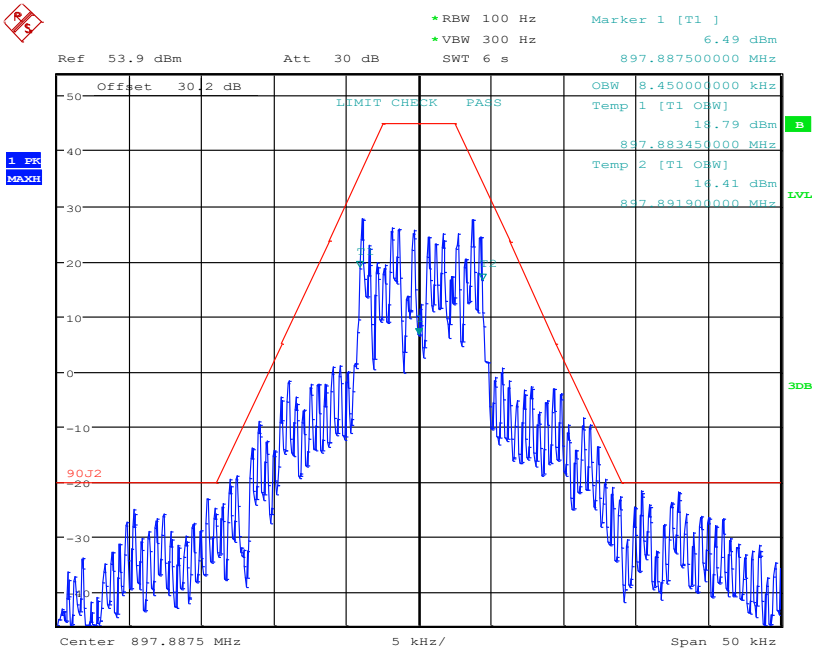
897.8875 MHz



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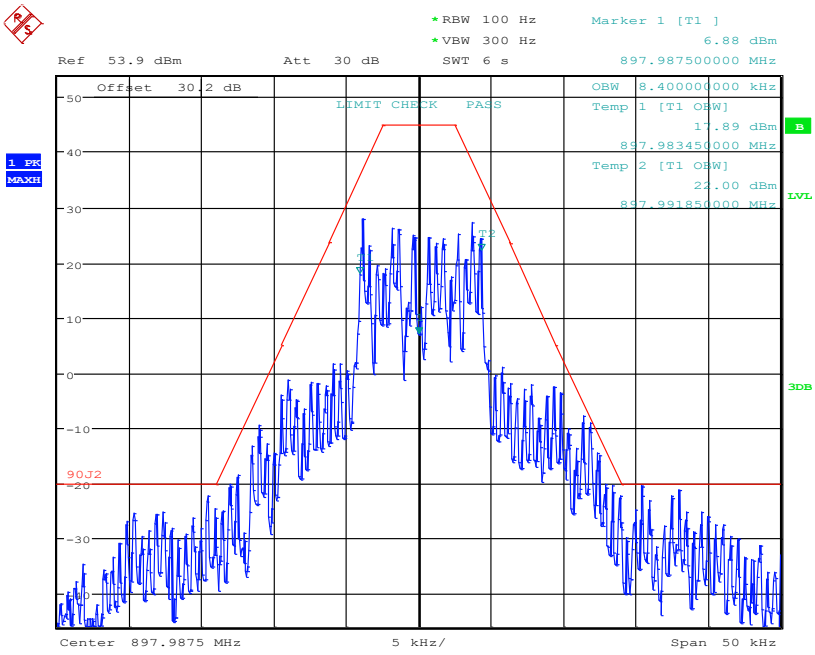
897.9875 MHz



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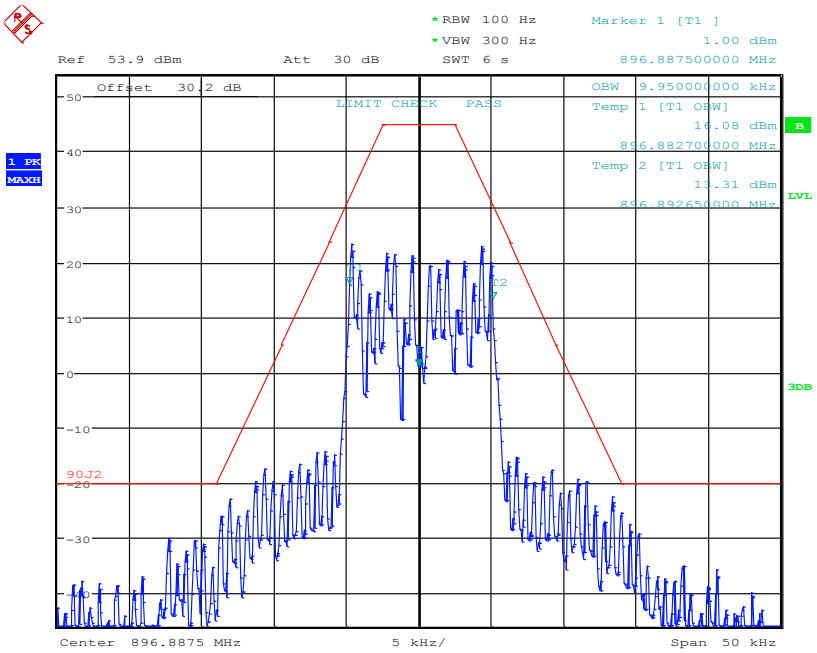
43 dBm rated power:

QPSK

896.8875 MHz



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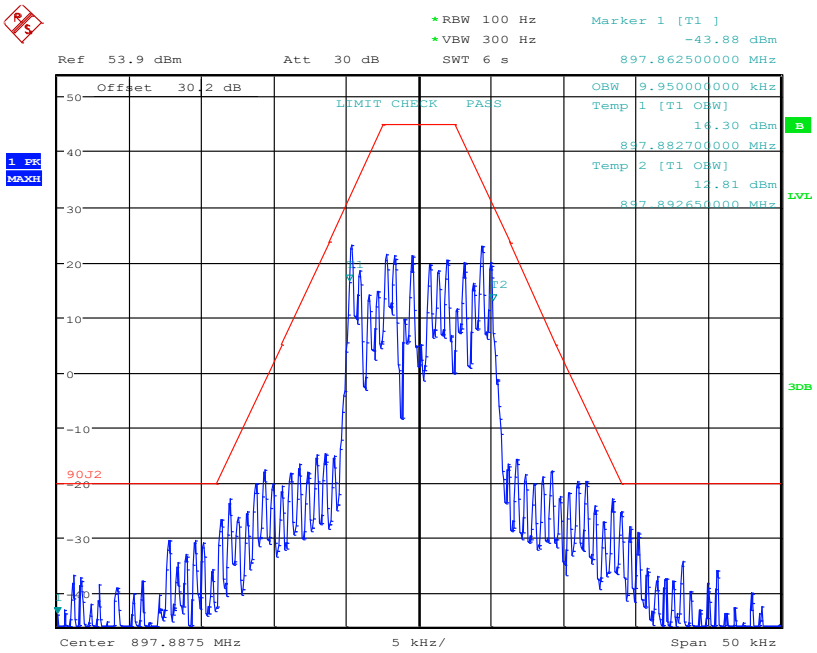
897.8875 MHz



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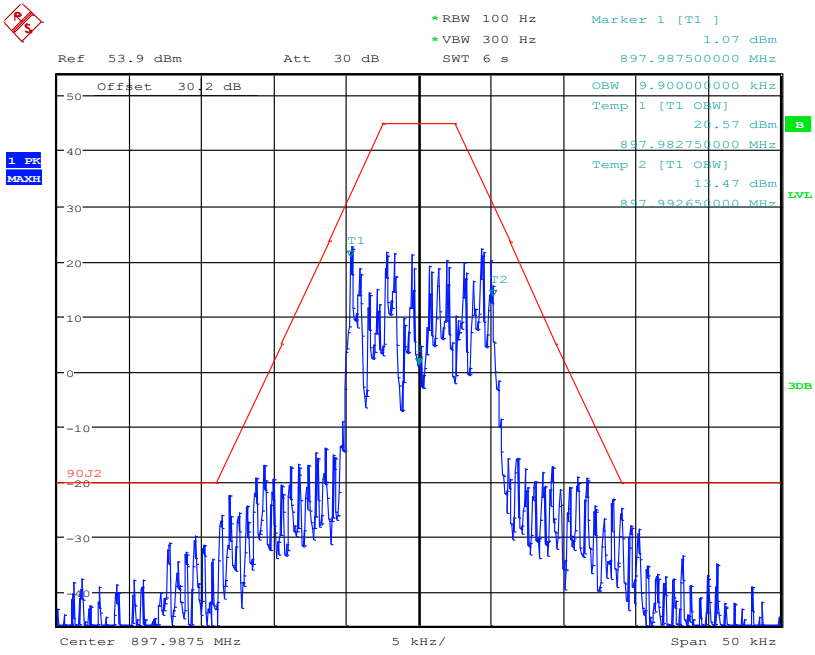
897.9875 MHz



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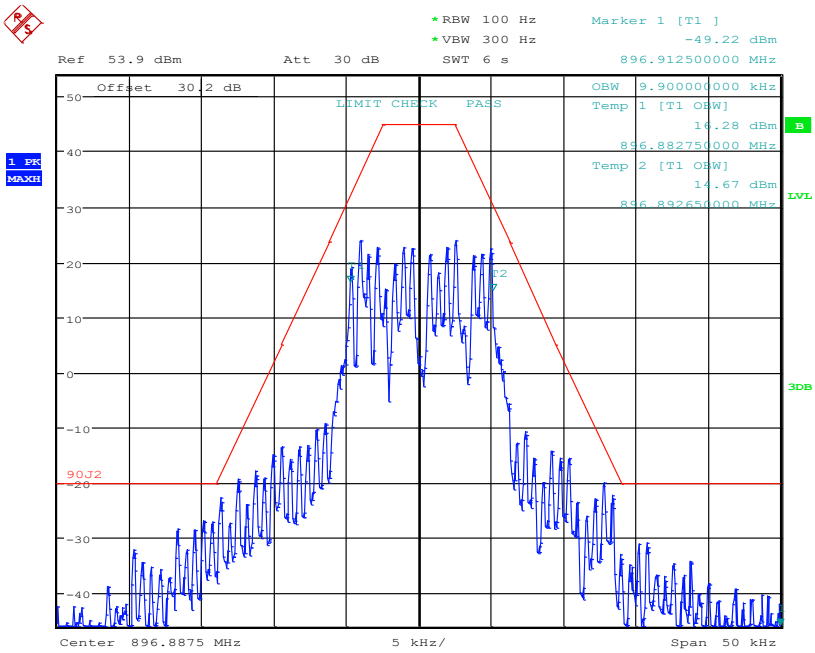
16QAM

896.8875 MHz



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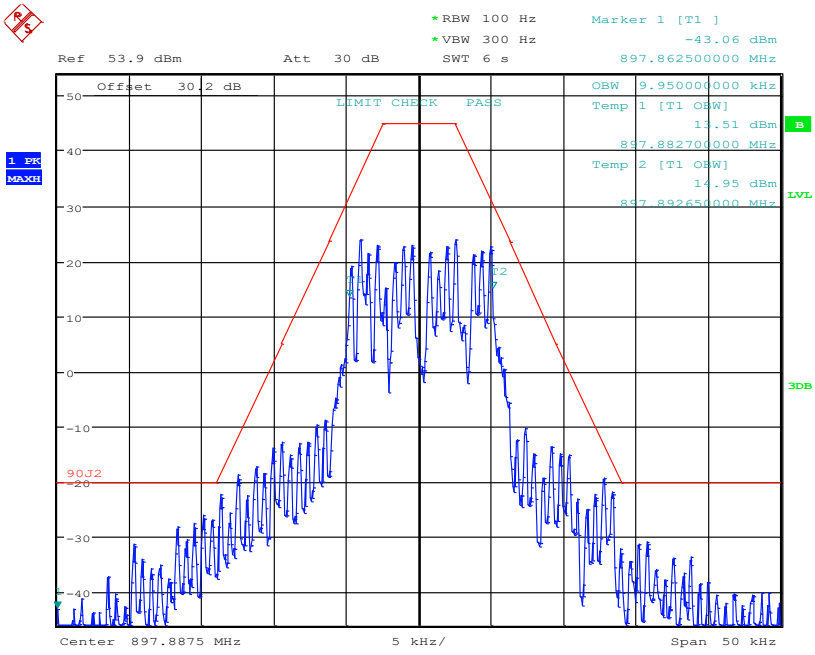
897.8875 MHz



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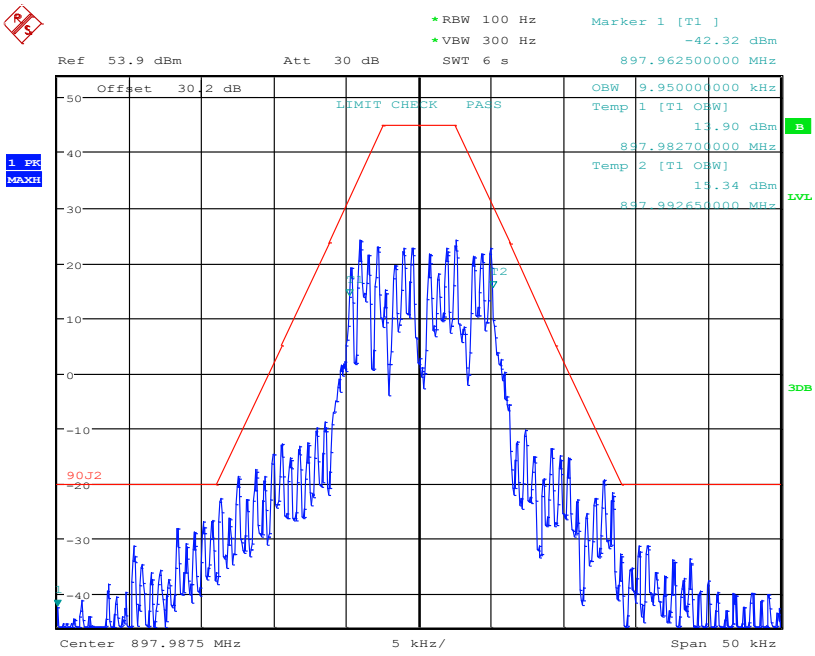
897.9875 MHz



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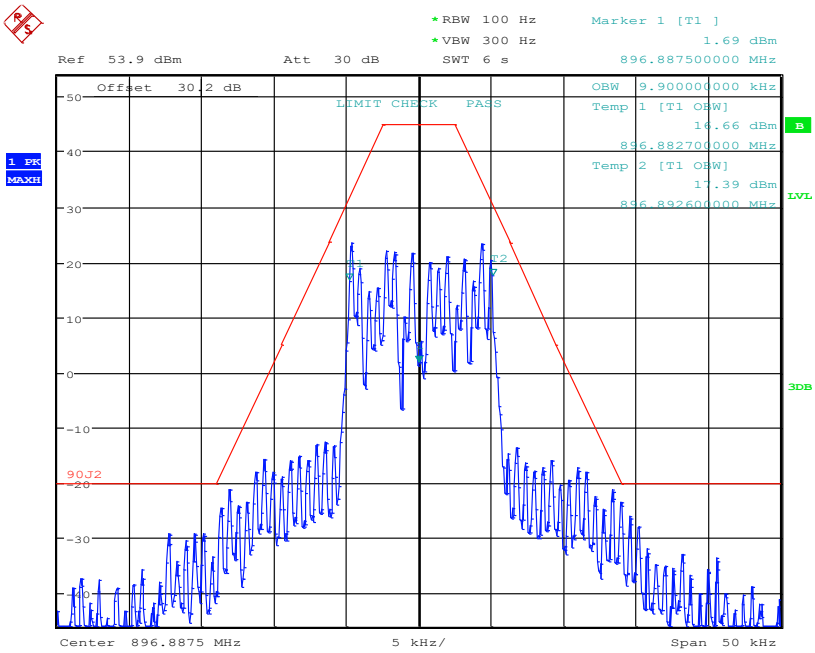
64QAM

896.8875 MHz



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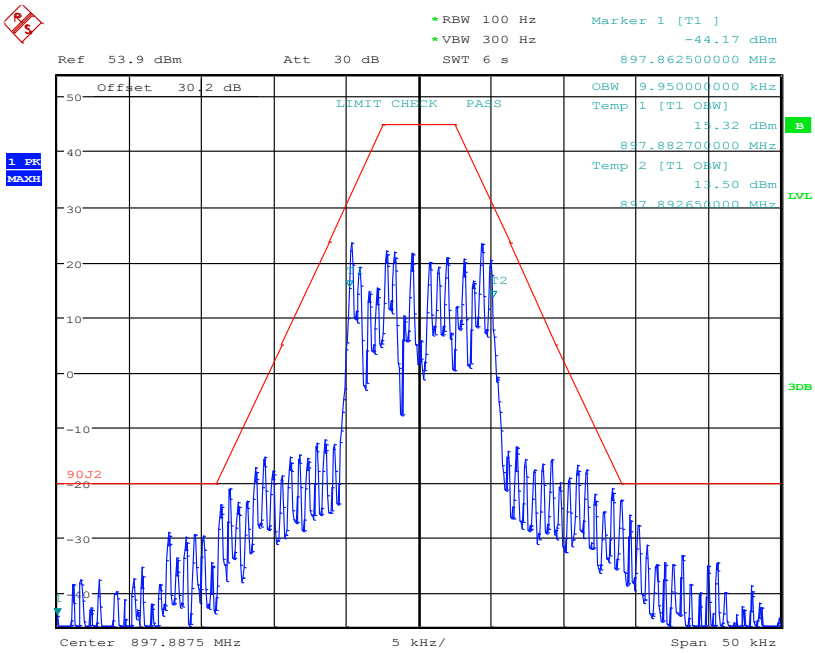
897.8875 MHz



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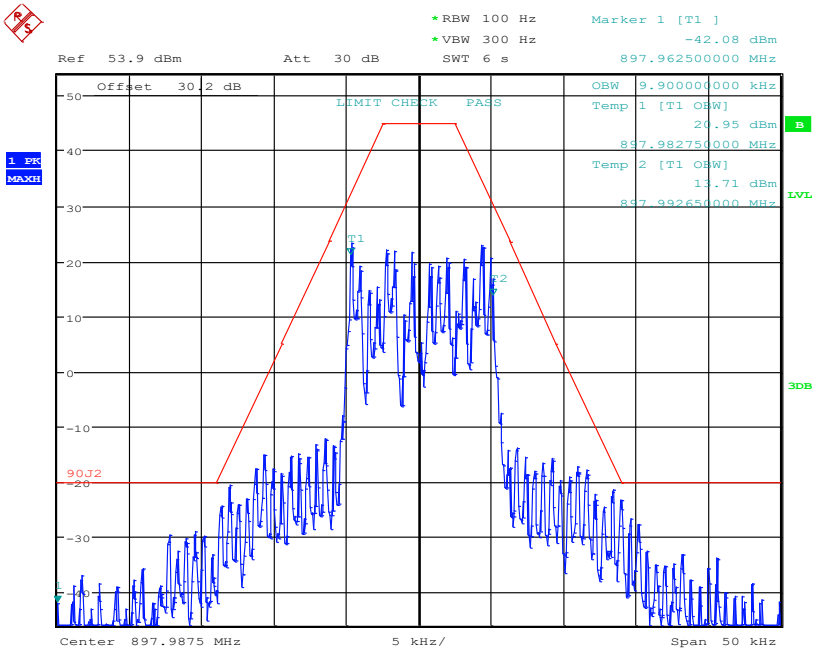
897.9875 MHz



Date: 22.MAR.2021 09:11:19

7 FCC §2.1053 & §90.210 - Spurious Radiated Emissions

7.1 Applicable Standards

According to FCC §90.210

TABLE 1 TO §90.210—APPLICABLE EMISSION MASKS

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
Below 25[1]	A or B	A or C
25-50	B	C
72-76	B	C
150-174[2]	B, D, or E	C, D or E
150 paging only	B	C
220-222	F	F
421-512[2 5]	B, D, or E	C, D, or E
450 paging only	B	G
806-809/851-854[6]	B	H
809-824/854-869[35]	B, D	D, G.
896-901/935-940	I	J
902-928	K	K
929-930	B	G
4940-4990 MHz	L or M	L or M
5850-5925[4]		
All other bands	B	C

7.2 Test Procedure

The transmitter was place onto a Styrofoam block. The unit was normally transmitting with a 50 ohm terminator connected to the antenna terminal.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT.

Emissions were investigated up to the tenth harmonic of the fundamental frequency.

After the emissions were found, the EUT was removed and replaced by a substituting antenna. A signal generator was connected to the substituting antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

7.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
HP	Spectrum Analyzer	E4446A	US44300386	2019-08-24	18 months
Sunol Science Corp	System Controller	SC99V	122303-1	N/R	N/R
Sunol Sciences	Antenna, Biconi-Log	JB3	A020106-2	2019-11-20	2 years
HP	Pre-Amplifier	8447D	2944A07030	2020-08-17	1 year
Agilent	Pre-Amplifier	8449B	3147A00400	2020-02-27	1 year
ETS Lindgren	Antenna, Horn	3117	00218973	2019-02-13	2 years
Sunol Sciences	Antenna, Horn	DRH-118	A052704	2019-04-02	2 years
Keysight Technologies	Vector Signal Generator	N5182B	MY51350070	2020-02-11	18 months
COM-POWER	Antenna, Dipole	AD-100 DB-4	721033DB1/2/3/4	2019-03-06	2 years
IW Microwave	157 Series 2.92 SM (x2) Armored 33 ft. Cable	KPS-1571AN-3960-KPS	DC 1917	2020-02-28	1 year
MDP Digital	Times Microwave LMR 400 UltraFex Coaxial Cable 35'	LMR400UF	BACL1904161	2020-05-20	1 year
-	SMA cable	-	C0003	Each Time[1]	Each Time[1]
-	SMA cable	-	C0006	Each Time[1]	Each Time[1]

Note[1]: This equipment was calibrated for each test.
Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

7.4 Test Environmental Conditions

Temperature:	20-21°C
Relative Humidity:	47-49 %
ATM Pressure:	101.4-101.6 kPa

The testing was performed by Christian McCaig on 2020-09-01 in 5 Meter Chamber 3.

7.5 Test Results

CW, Middle channel tested (897.8875 MHz)

Indicated		Azimuth (degree)	Test Antenna		Substituted					Limit (dBm)	Margin (dB)
Frequency (MHz)	S.A. Amp. (dBuV)		Height (cm)	Polarity (H/V)	Frequency (MHz)	Level (dBm)	Ant. Gain Correction (dBd/dBi)	Cable Loss (dB)	Absolute Level (dBm)		
875	47.4	300	160	H	875	-50.08	3.6	3.34	-49.82	-20	-29.82
875	42.15	180	130	V	875	-53.68	3.6	3.34	-53.42	-20	-33.42
1795.775	56.62	38	128	H	1795.775	-45.15	8.18	1.46	-38.43	-20	-18.43
1795.775	51.02	332	130	V	1795.775	-50.78	8.18	1.46	-44.06	-20	-24.06
2693.6625	65.36	275	130	H	2693.6625	-34.09	9.511	1.9	-26.479	-20	-6.479
2693.6625	66.31	227	157	V	2693.6625	-33.96	9.511	1.9	-26.349	-20	-6.349
3591.55	58.5	275	105	H	3591.55	-39.19	9.699	2.22	-31.711	-20	-11.711
3591.55	62.18	330	103	V	3591.55	-36.36	11.15	2.22	-27.43	-20	-7.43
4489.4375	46.78	275	100	H	4489.4375	-51.32	11.15	2.5	-42.67	-20	-22.67
4489.4375	48.16	10	245	V	4489.4375	-50.15	8.939	2.5	-43.711	-20	-23.711
5387.325	64.85	315	250	H	5387.325	-30.62	11.19	3.11	-22.54	-20	-2.54
5387.325	68.11	16	250	V	5387.325	-28.27	11.19	3.11	-20.19	-20	-0.19

Note: Pre-scan was performed on all low, middle and high channels. Middle channel was selected for formal testing as it was determined to show worst case spurious emissions

8 FCC §2.1051 & §90.210 - Spurious Emissions at Antenna Terminals

8.1 Applicable Standards

According to FCC §90.210

TABLE 1 TO §90.210—APPLICABLE EMISSION MASKS

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
Below 25[1]	A or B	A or C
25-50	B	C
72-76	B	C
150-174[2]	B, D, or E	C, D or E
150 paging only	B	C
220-222	F	F
421-512[2 5]	B, D, or E	C, D, or E
450 paging only	B	G
806-809/851-854[6]	B	H
809-824/854-869[35]	B, D	D, G.
896-901/935-940	I	J
902-928	K	K
929-930	B	G
4940-4990 MHz	L or M	L or M
5850-5925[4]		
All other bands	B	C

(j) *Emission Mask J.* For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) as follows:

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 2.5 kHz, but no more than 6.25 kHz: At least 53 log (f_d/2.5) dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 6.25 kHz, but no more than 9.5 kHz: At least 103 log (f_d/3.9) dB;

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 9.5 kHz: At least 157 log (f_d/5.3) dB, or 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

8.2 Test Procedure

Conducted spurious emissions:

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz for measurements up to 1GHz and set to 1 MHz for measurements up to the 10th harmonic.

Band-edge emissions:

According to ANSI C63.26-2015 section 5.7 Unwanted (out-of-band and spurious) conducted emissions measurement procedures (conducted test at antenna port):

A RBW narrower than the specified reference bandwidth can be used (generally limited to no less than 1% of the OBW).

8.3 Test Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Dates	Calibration Interval
Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2019-11-07	2 years
-	RF Cable	-	-	Each time[1]	N/A
-	30dB Attenuator	-	-	Each time[1]	N/A

Note[1]: Equipment was calibrated for each test.
Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

8.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	32 %
ATM Pressure:	101.4-102 kPa

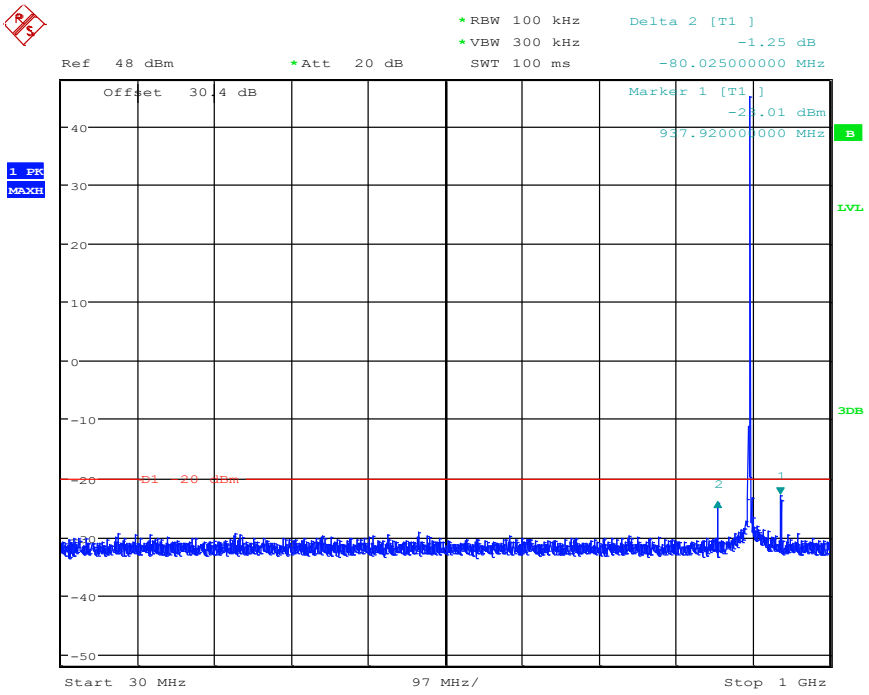
The testing was performed by Christian McCaig from 2021-01-19 to 2021-01-22 and 2021-03-22 in the RF Site.

8.5 Test Results

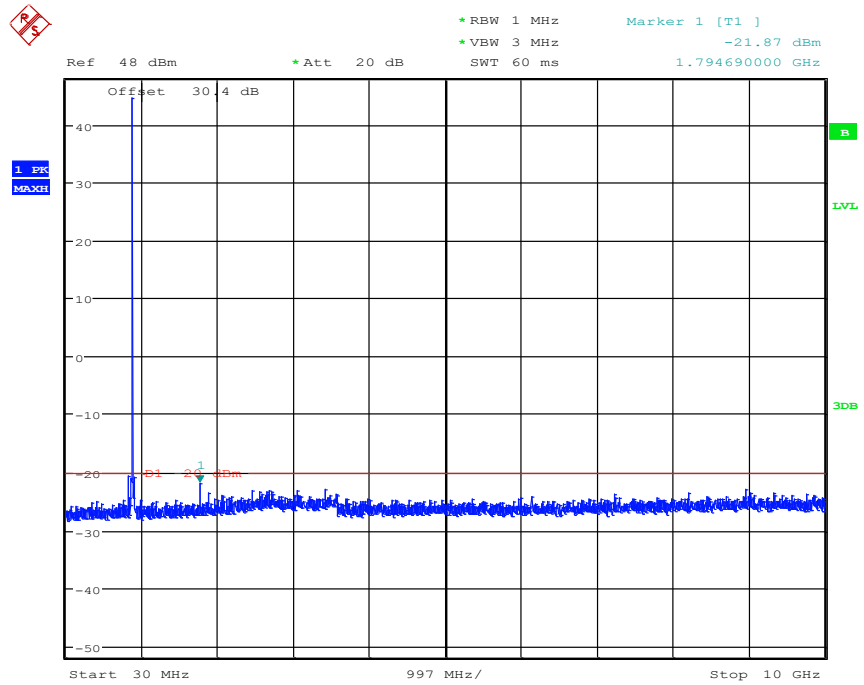
Please refer to the following plots.

Conducted Spurious Emissions:
Worst Case: CW mode, middle channel (897.8875 MHz)

30 MHz-1 GHz



1 GHz-5 GHz

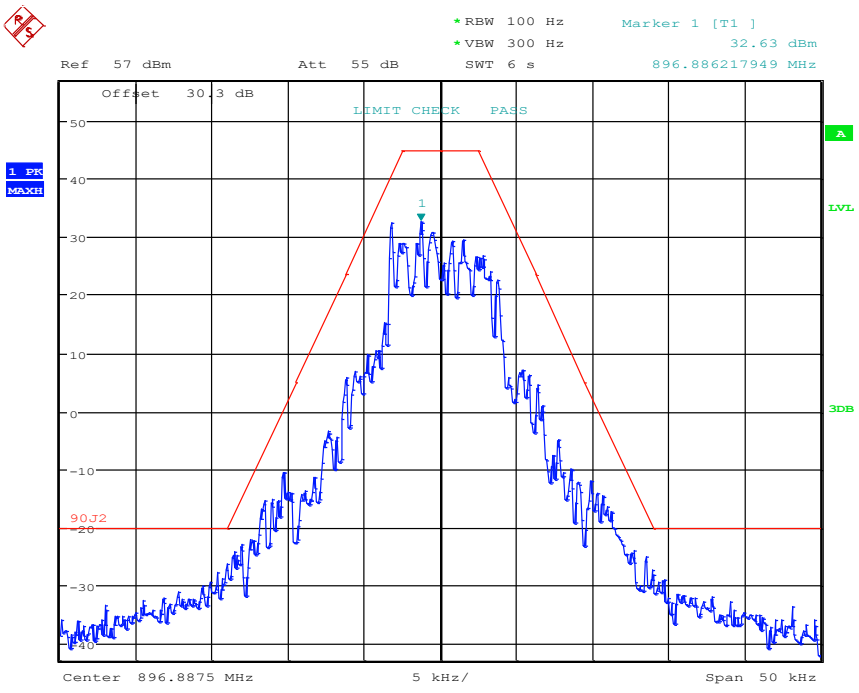


Note: Pre-scan was performed on all low, middle and high channels. Middle channel was selected for formal testing as it was determined to show worst case spurious emissions

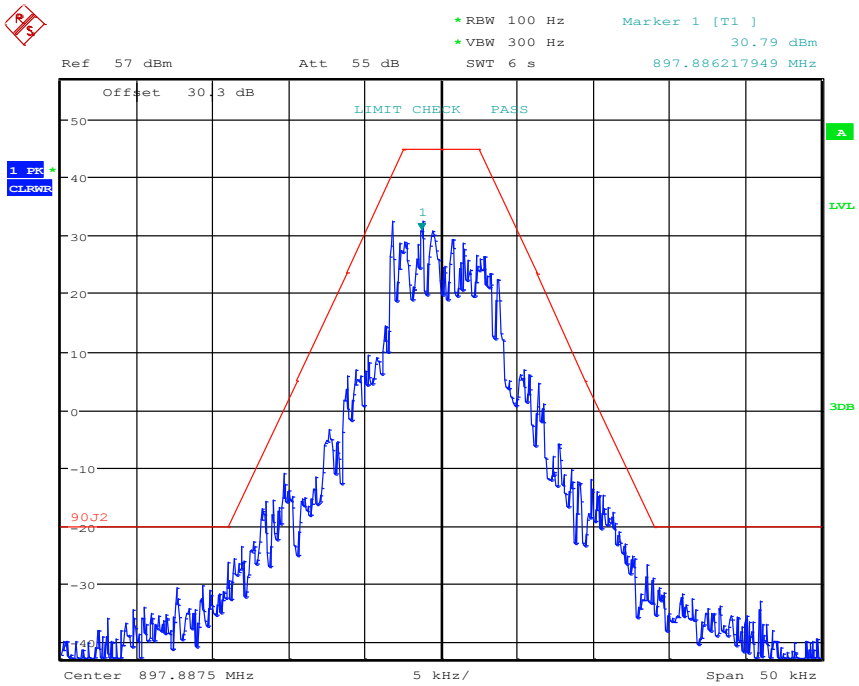
Emission Mask J:
45 dBm rated power:

2FSK

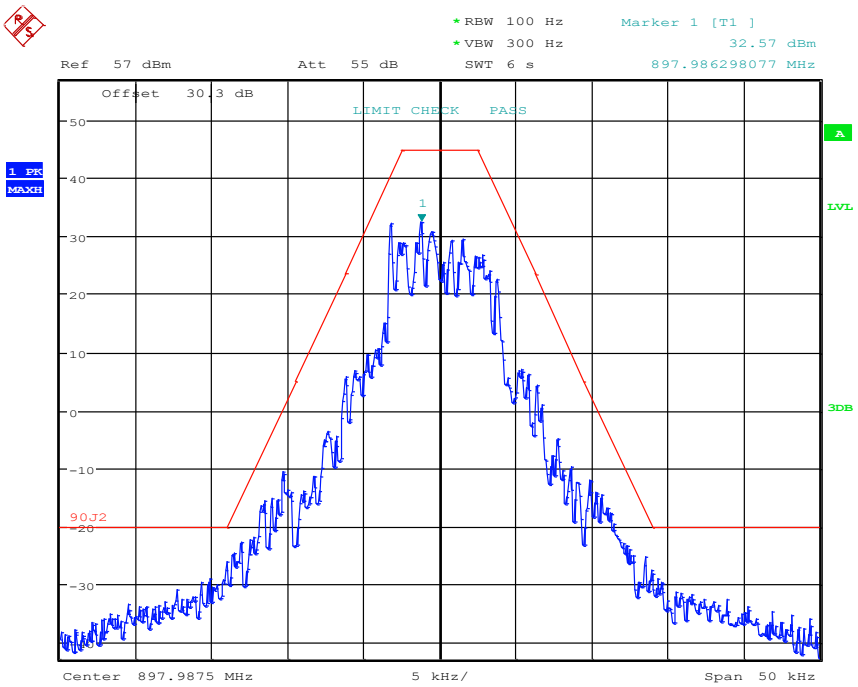
896.8875 MHz



897.8875 MHz

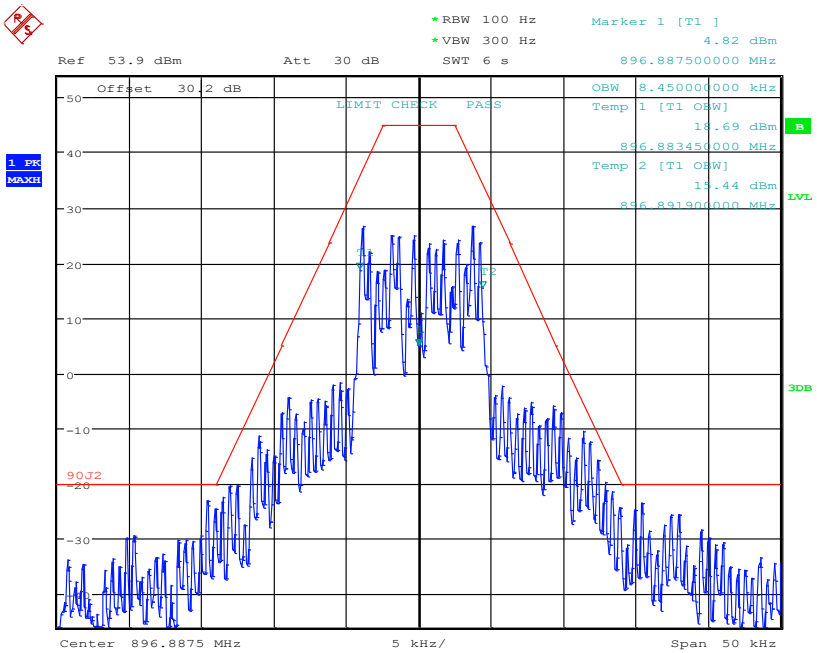


897.9875 MHz



QPSK

896.8875 MHz



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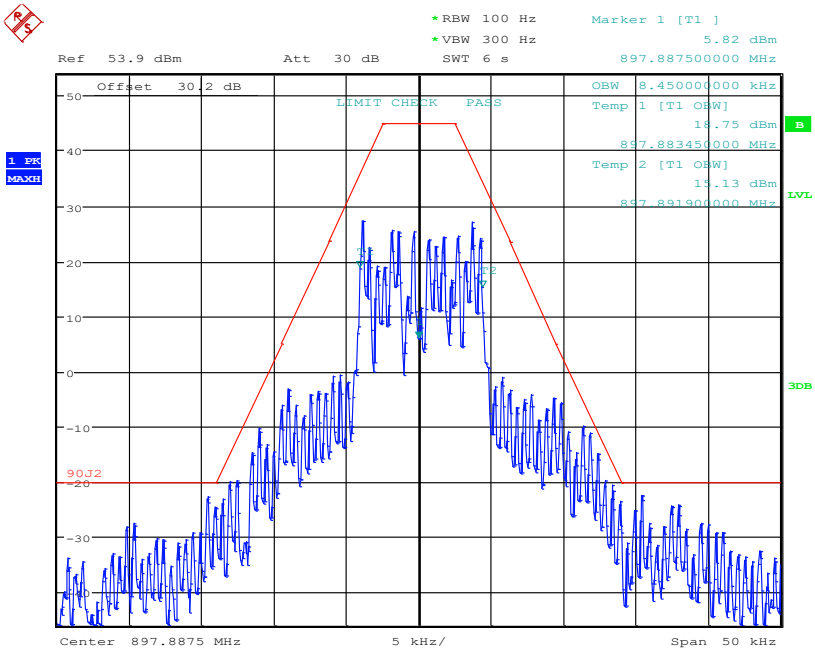
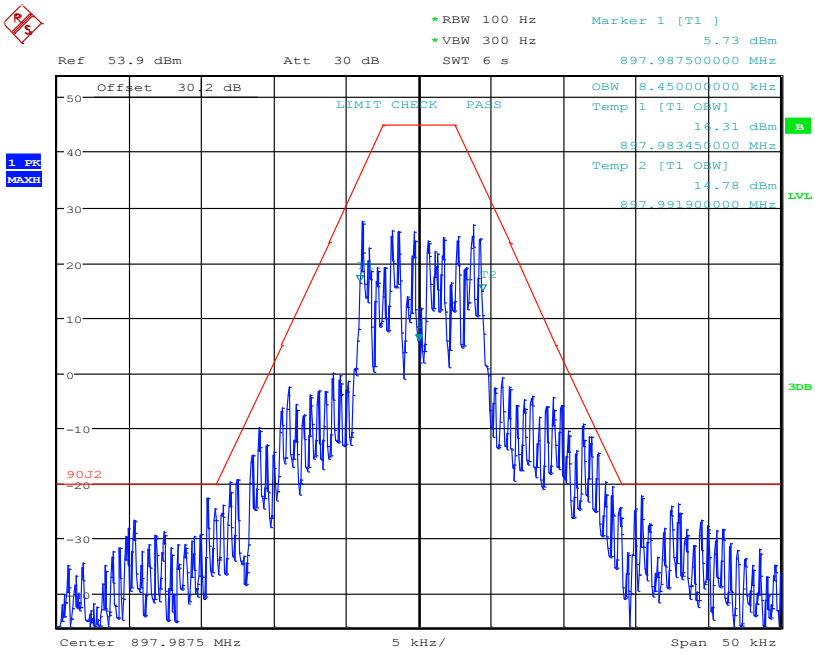
897.8875 MHz



Date: 22.MAR.2021 10:20:31

897.9875 MHz



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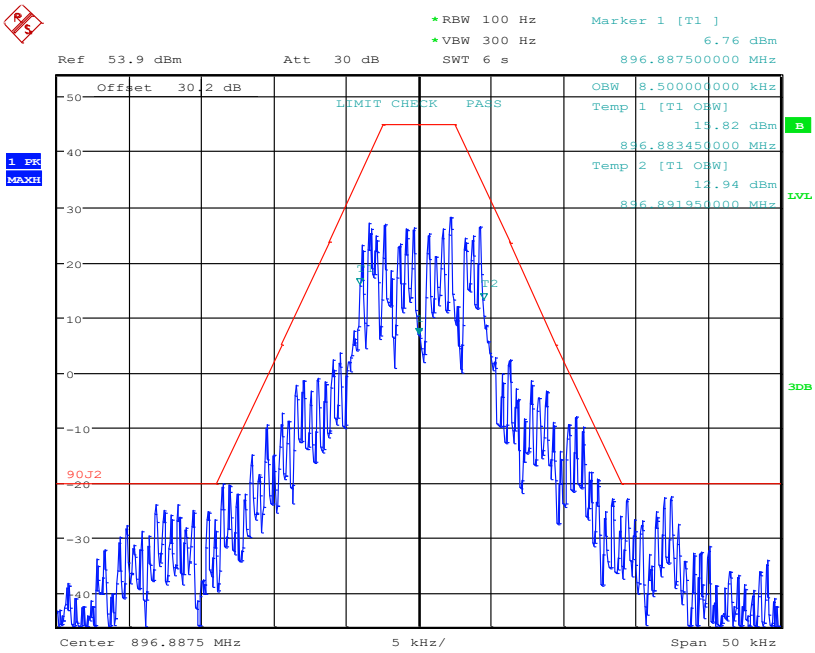
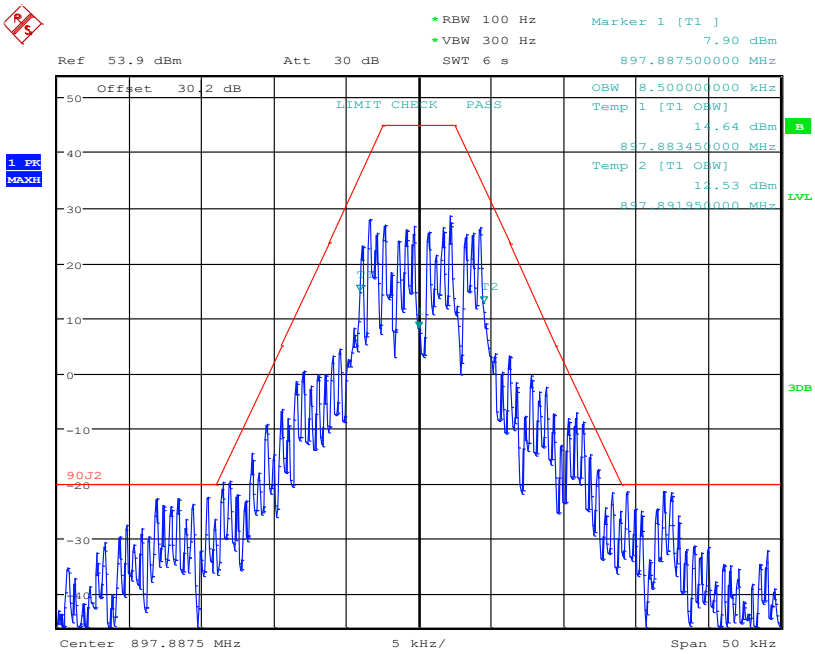
16QAM

896.8875 MHz



Date: 22.MAR.2021 10:13:13

897.8875 MHz



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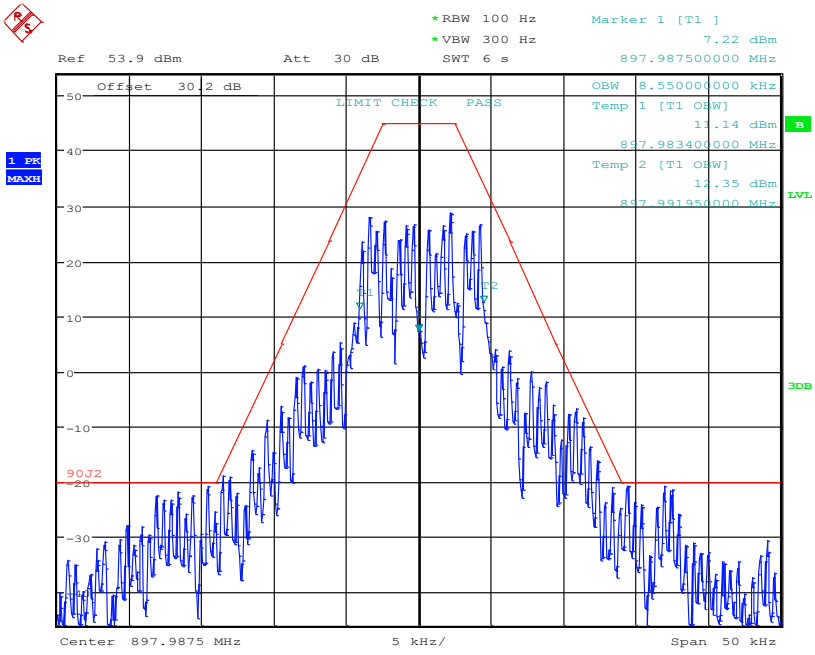

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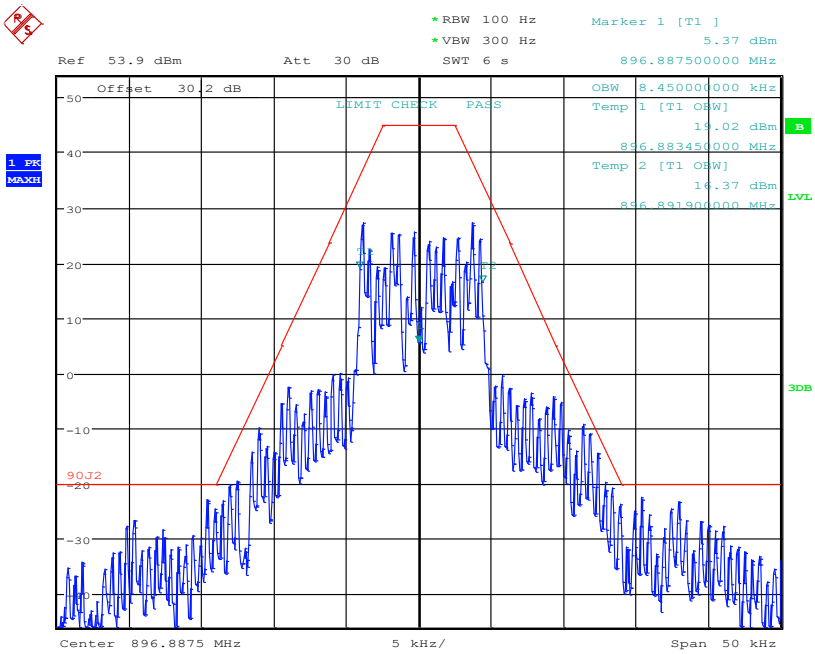
64QAM

896.8875 MHz



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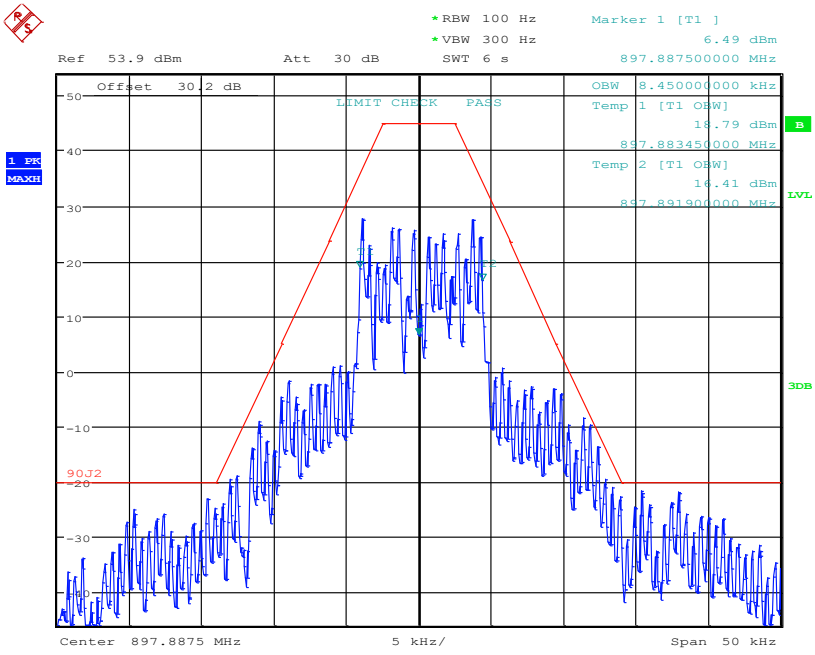

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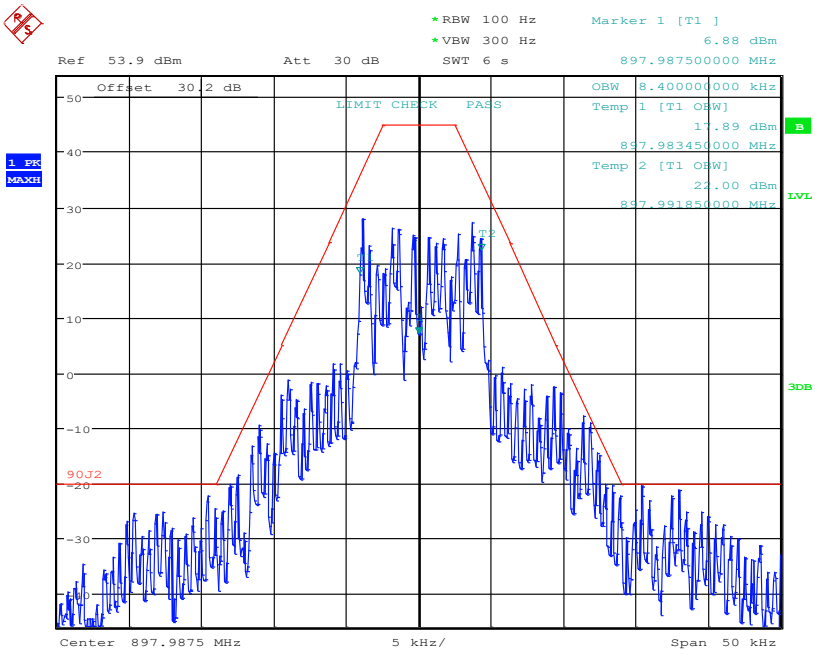

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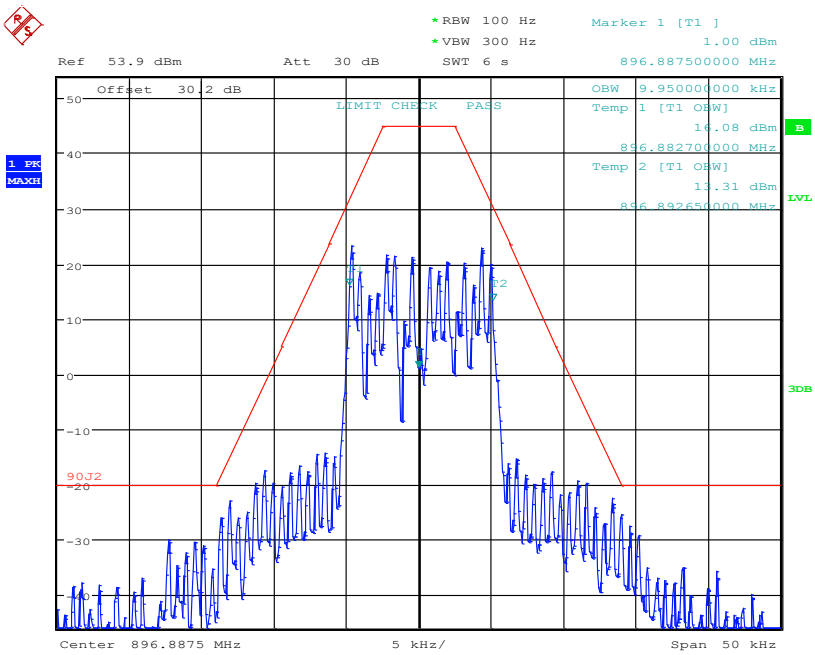
43 dBm rated power:

QPSK

896.8875 MHz



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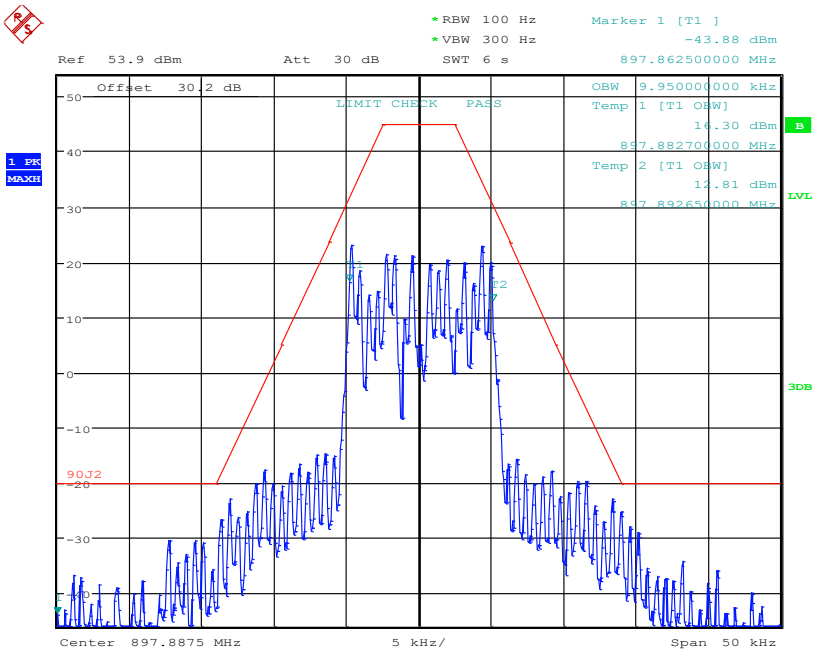
897.8875 MHz



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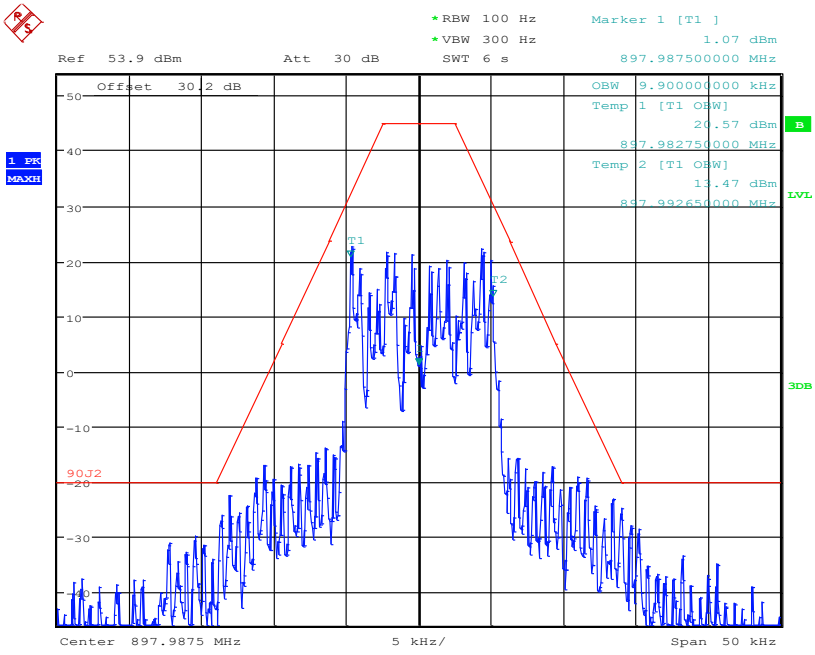

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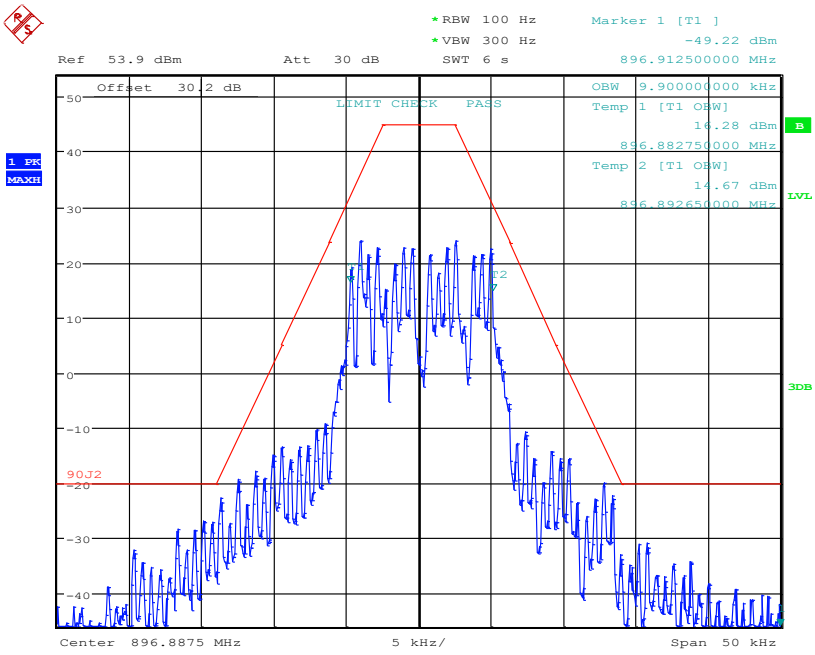
16QAM

896.8875 MHz



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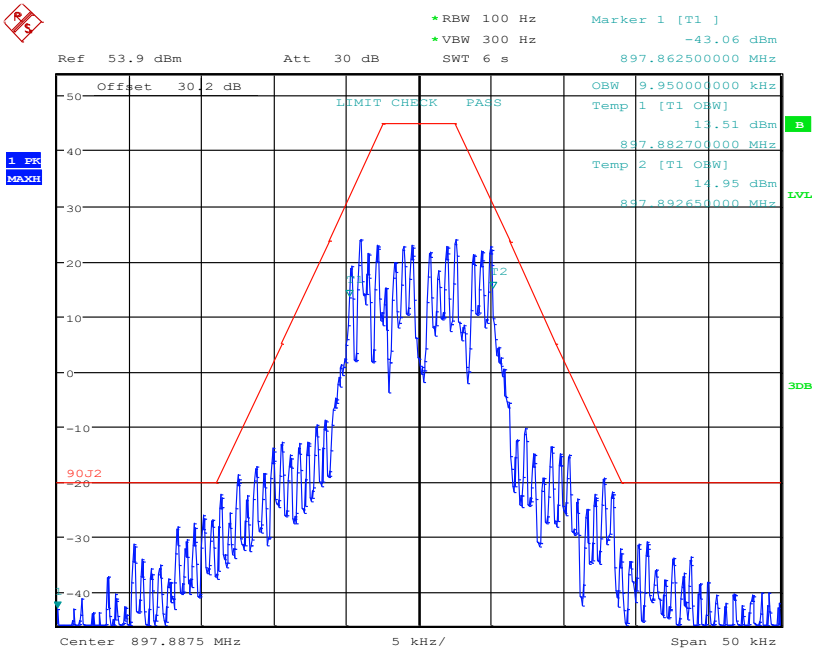
897.8875 MHz



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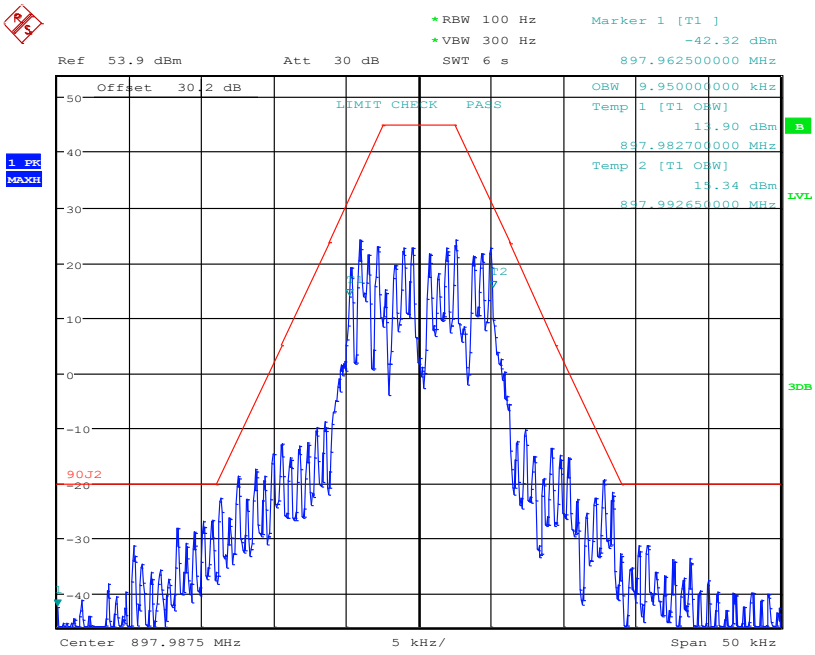

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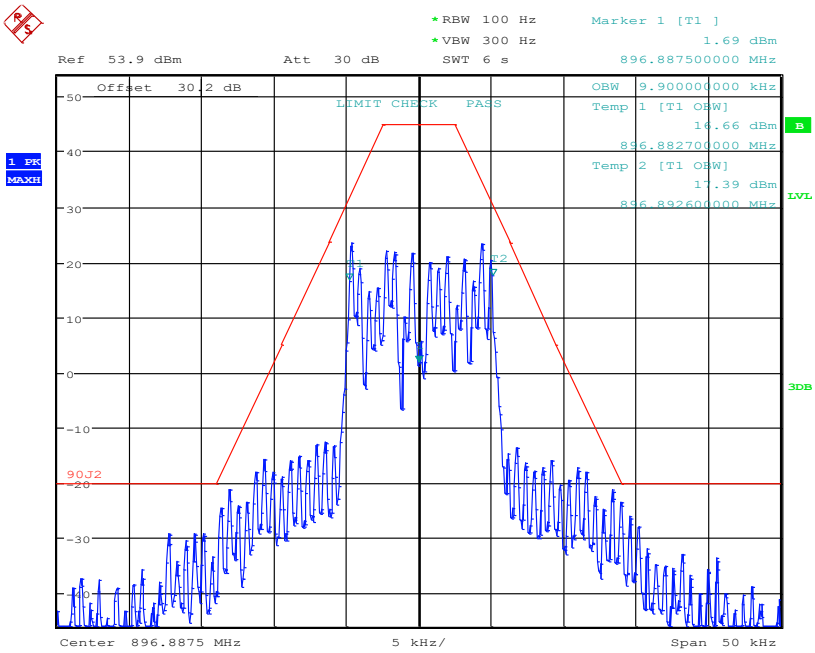
64QAM

896.8875 MHz



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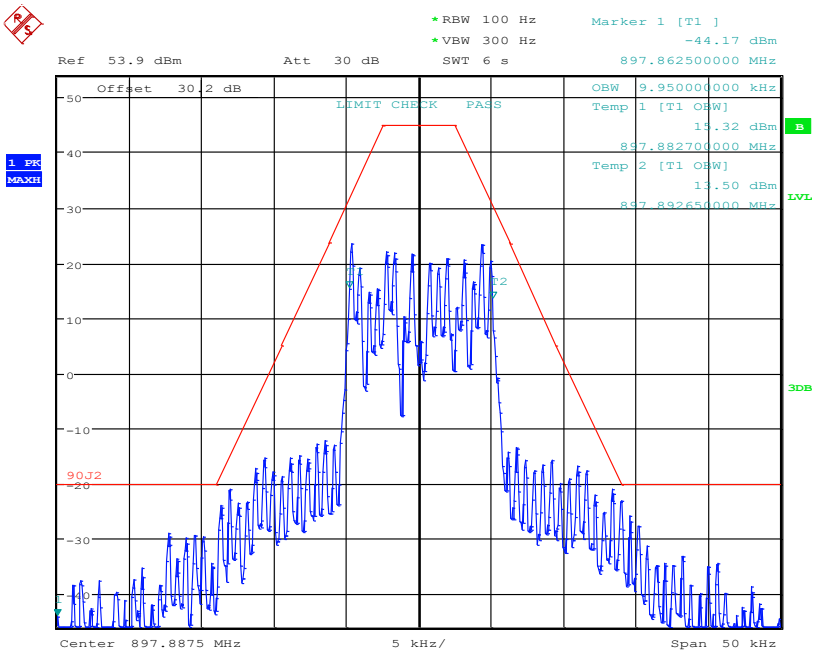

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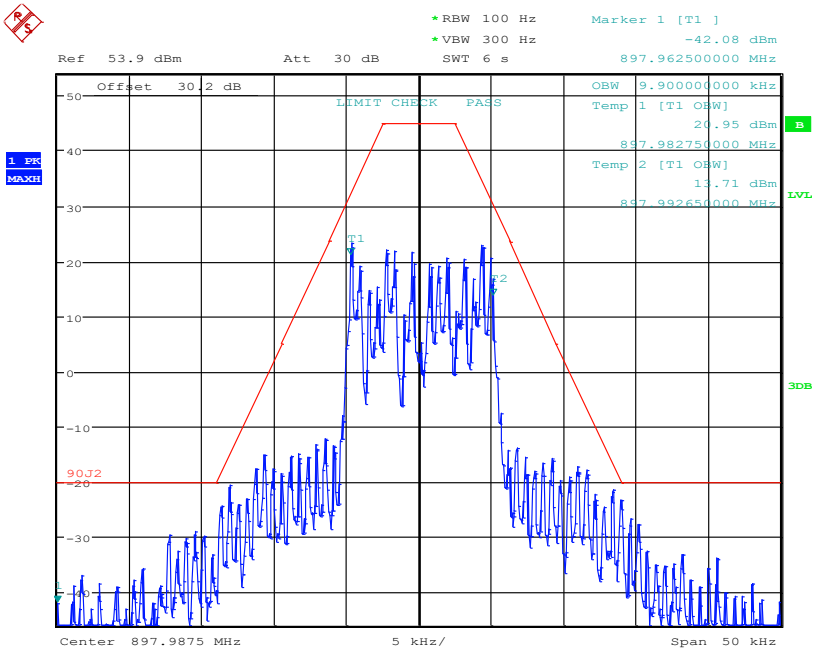
897.9875 MHz



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9 FCC §2.1055 & §90.213 - Frequency Tolerance

9.1 Applicable Standard

According to FCC Part 90.213,

§90.213 Frequency stability.

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

TABLE 1 TO §90.213(a)—MINIMUM FREQUENCY STABILITY

[Parts per million (ppm)]

Frequency range (MHz)	Fixed and base stations	Mobile stations	
		Over 2 watts output power	2 watts or less output power
Below 25	[1 2 3]100	100	200
25-50	20	20	50
72-76	5		50
150-174	[5 11]5	[6]5	[4 6]50
216-220	1.0		1.0
220-222[12]	0.1	1.5	1.5
421-512	[7 11 14]2.5	[8]5	[8]5
806-809	[14]1.0	1.5	1.5
809-824	[14]1.5	2.5	2.5
851-854	1.0	1.5	1.5
854-869	1.5	2.5	2.5
896-901	[14]0.1	1.5	1.5
902-928	2.5	2.5	2.5
902-928[13]	2.5	2.5	2.5
929-930	1.5		
935-940	0.1	1.5	1.5
1427-1435	[9]300	300	300
Above 2450[10]			

9.2 Test Procedure

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

(1) From −30° to + 50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

(2) From −20° to + 50° centigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radiobeacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to-Point Microwave Radio Service under part 21 of this chapter, equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter, and equipment authorized for use in the Family Radio Service under part 95 of this chapter.

(3) From 0° to + 50° centigrade for equipment to be licensed for use in the Radio Broadcast Services under part 73 of this chapter.

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the

components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(c) In addition to all other requirements of this section, the following information is required for equipment incorporating heater type crystal oscillators to be used in mobile stations, for which type acceptance is first requested after March 25, 1974, except for battery powered, hand carried, portable equipment having less than 3 watts mean output power.

(1) Measurement data showing variation in transmitter output frequency from a cold start and the elapsed time necessary for the frequency to stabilize within the applicable tolerance. Tests shall be made after temperature stabilization at each of the ambient temperature levels; the lower temperature limit, 0° centigrade and + 30° centigrade with no primary power applied.

(2) Beginning at each temperature level specified in paragraph (c)(1) of this section, the frequency shall be measured within one minute after application of primary power to the transmitter and at intervals of no more than one minute thereafter until ten minutes have elapsed or until sufficient measurements are obtained to indicate clearly that the frequency has stabilized within the applicable tolerance, whichever time period is greater. During each test, the ambient temperature shall not be allowed to rise more than 10° centigrade above the respective beginning ambient temperature level.

(3) The elapsed time necessary for the frequency to stabilize within the applicable tolerance from each beginning ambient temperature level as determined from the tests specified in this paragraph shall be specified in the instruction book for the transmitter furnished to the user.

(4) When it is impracticable to subject the complete transmitter to this test because of its physical dimensions or power rating, only its frequency determining and stabilizing portions need be tested.

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

(e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c), and (d) of this section. (For example measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment.)

9.3 Test Equipment List and Details

Manufacturer	Descriptions	Models	Serial Numbers	Calibration Dates	Calibration Interval
Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2019-11-07	2 years
-	RF Cable	-	-	Each time[1]	N/A
-	30dB Attenuator	-	-	Each time[1]	N/A
TCR	DC Power Supply	TCR80S34-2-0V	92D-6839	N/A	N/A
Espec	Chamber, Humidity	ESL-4CA	18010	2020-06-26	1 year

Note[1]: Equipment was calibrated for each test.
Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

9.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	32 %
ATM Pressure:	101.4-102 kPa

The testing was performed by Christian McCaig on 2020-01-22 in the RF Site.

9.5 Test Results

Note: Testing done using CW mode

896.8875MHz:

Temperature (°C)/Voltage Conditions	Reference Frequency (MHz)	Tested Frequency (MHz)	Frequency Deviation (ppm)	Limit (ppm)	Result
-30/normal voltage (24V)	896.8875	896.887476	-0.026802	±1.5	pass
-20/normal voltage (24V)	896.8875	896.887527	0.030104	±1.5	pass
-10/normal voltage (24V)	896.8875	896.887584	0.093657	±1.5	pass
0/normal voltage (24V)	896.8875	896.887716	0.240833	±1.5	pass
10/normal voltage (24V)	896.8875	896.887752	0.280972	±1.5	pass
20/normal voltage (24V)	896.8875	896.887812	0.347870	±1.5	pass
30/normal voltage (24V)	896.8875	896.887770	0.301041	±1.5	pass
40/normal voltage (24V)	896.8875	896.887812	0.347870	±1.5	pass
50/normal voltage (24V)	896.8875	896.887872	0.414768	±1.5	pass
20/Low Voltage (20.4V)	896.8875	896.887641	0.157210	±1.5	pass
20/High Voltage (27.6V)	896.8875	896.887632	0.147176	±1.5	pass

897.8875MHz:

Temperature (°C)/Voltage Conditions	Reference Frequency (MHz)	Tested Frequency (MHz)	Frequency Deviation (ppm)	Limit (ppm)	Result
-30/normal voltage (24V)	897.8875	897.887497	-0.003341	±1.5	pass
-20/normal voltage (24V)	897.8875	897.887530	0.033412	±1.5	pass
-10/normal voltage (24V)	897.8875	897.887596	0.106918	±1.5	pass
0/normal voltage (24V)	897.8875	897.887716	0.240565	±1.5	pass
10/normal voltage (24V)	897.8875	897.887758	0.287341	±1.5	pass
20/normal voltage (24V)	897.8875	897.887815	0.350823	±1.5	pass
30/normal voltage (24V)	897.8875	897.887764	0.294023	±1.5	pass
40/normal voltage (24V)	897.8875	897.887806	0.340800	±1.5	pass
50/normal voltage (24V)	897.8875	897.887872	0.414306	±1.5	pass
20/Low Voltage (20.4V)	897.8875	897.887644	0.160376	±1.5	pass
20/High Voltage (27.6V)	897.8875	897.887641	0.157035	±1.5	pass

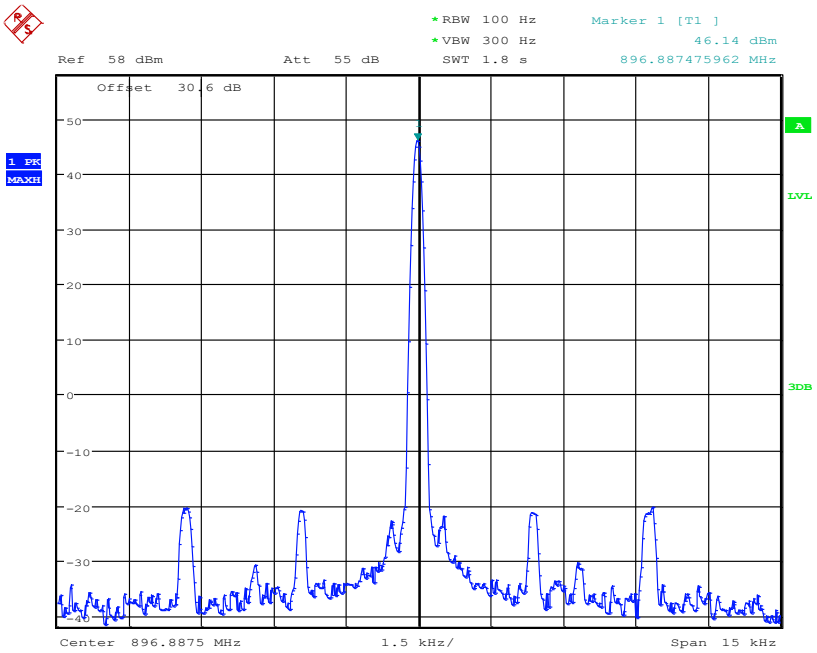
896.9875MHz:

Temperature (°C)/Voltage Conditions	Reference Frequency (MHz)	Tested Frequency (MHz)	Frequency Deviation (ppm)	Limit (ppm)	Result
-30/normal voltage (24V)	897.9875	897.987515	0.016704	±1.5	pass
-20/normal voltage (24V)	897.9875	897.987527	0.030067	±1.5	pass
-10/normal voltage (24V)	897.9875	897.987611	0.123610	±1.5	pass
0/normal voltage (24V)	897.9875	897.987707	0.230515	±1.5	pass
10/normal voltage (24V)	897.9875	897.987767	0.297332	±1.5	pass
20/normal voltage (24V)	897.9875	897.987815	0.350784	±1.5	pass
30/normal voltage (24V)	897.9875	897.987761	0.290650	±1.5	pass
40/normal voltage (24V)	897.9875	897.987797	0.330740	±1.5	pass
50/normal voltage (24V)	897.9875	897.987869	0.410919	±1.5	pass
20/Low Voltage (20.4V)	897.9875	897.987644	0.160359	±1.5	pass
20/High Voltage (27.6V)	897.9875	897.987641	0.157018	±1.5	pass

Please refer to the following plots for measurement results.

-30 °C

896.8875 MHz



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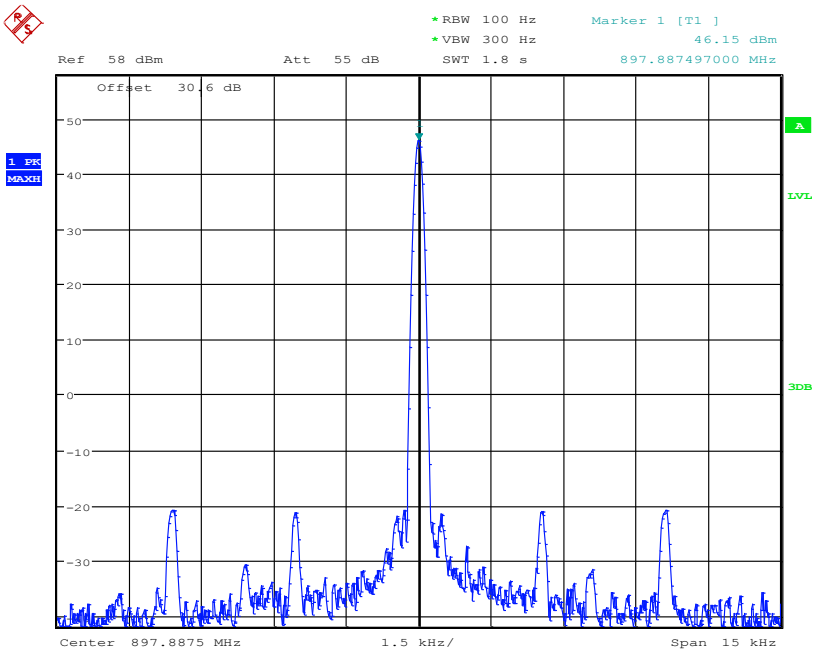
897.8875 MHz



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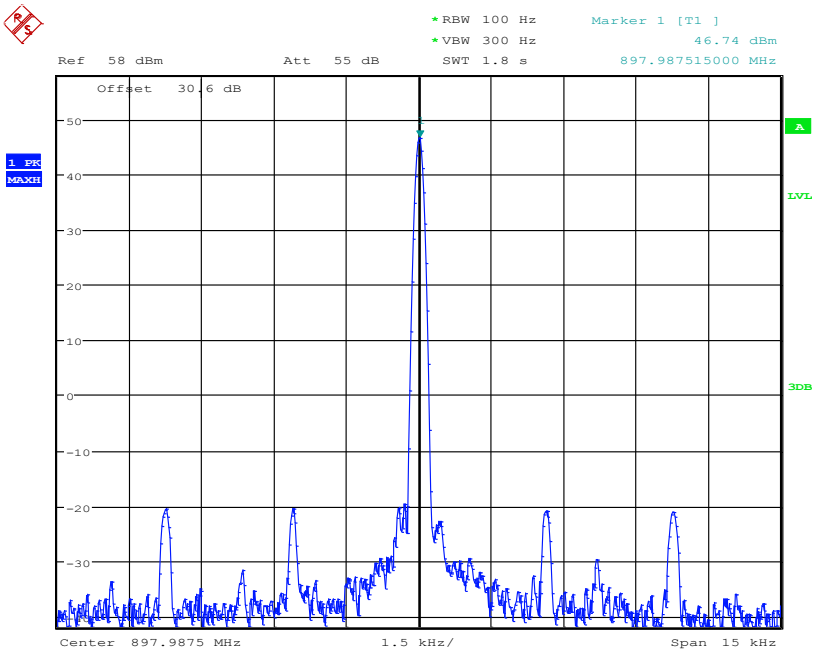

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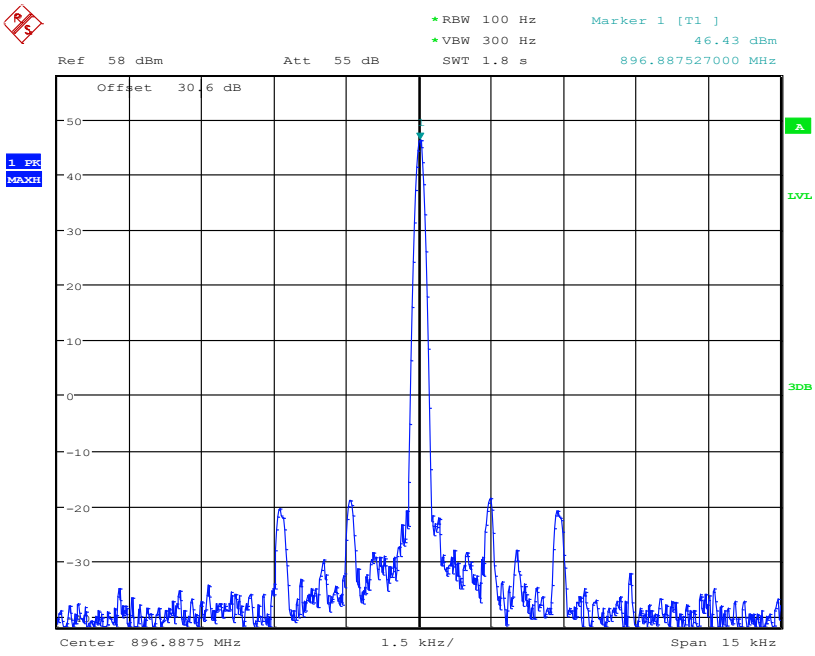
-20 °C

896.8875 MHz



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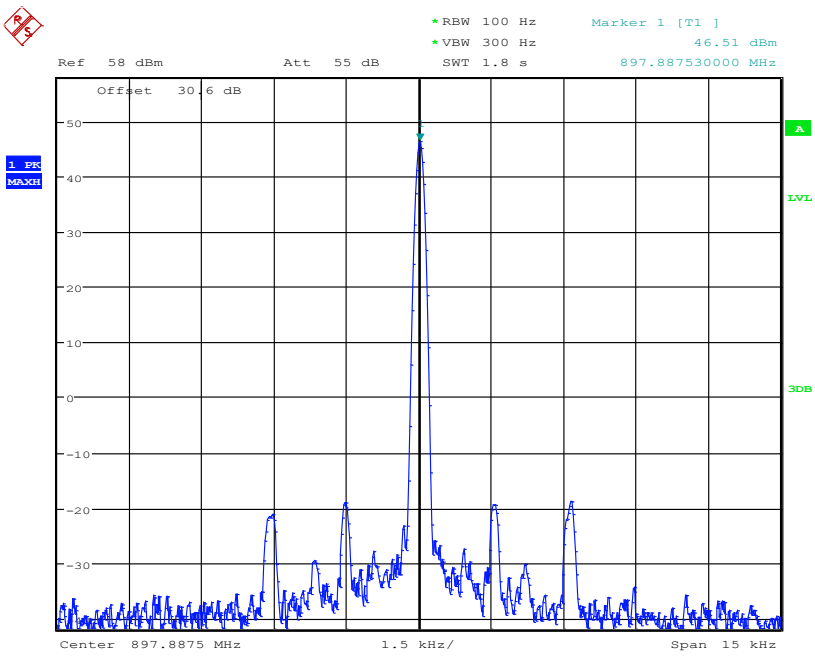

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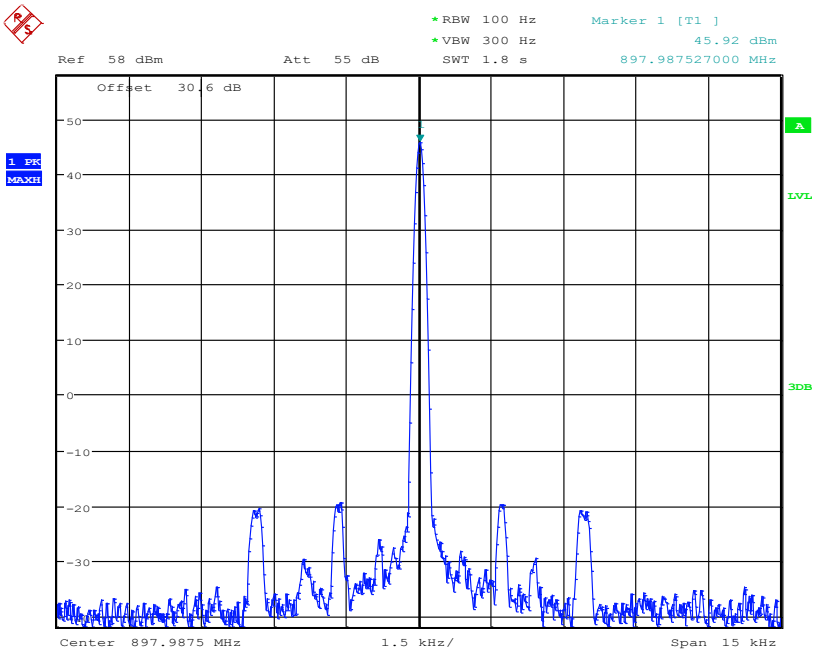

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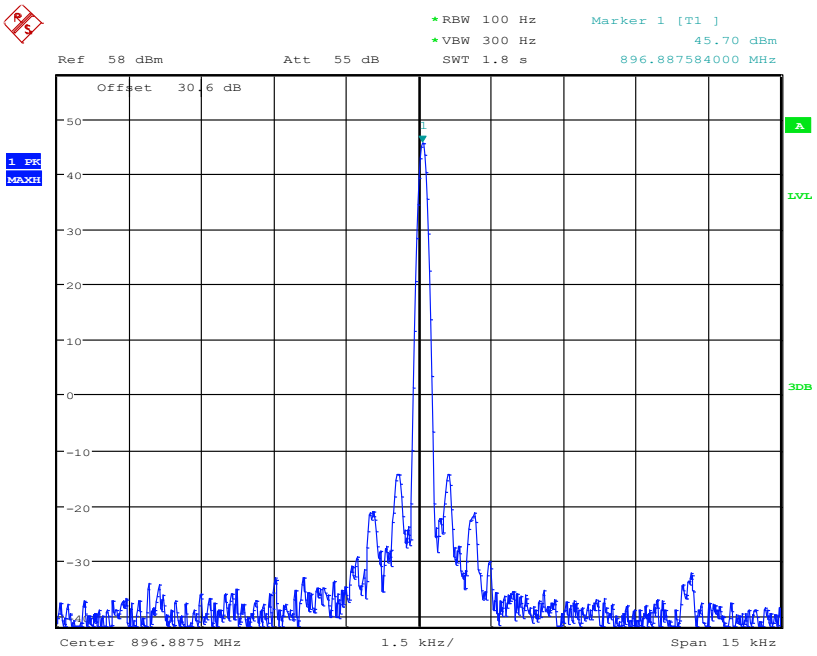
-10 °C

896.8875 MHz



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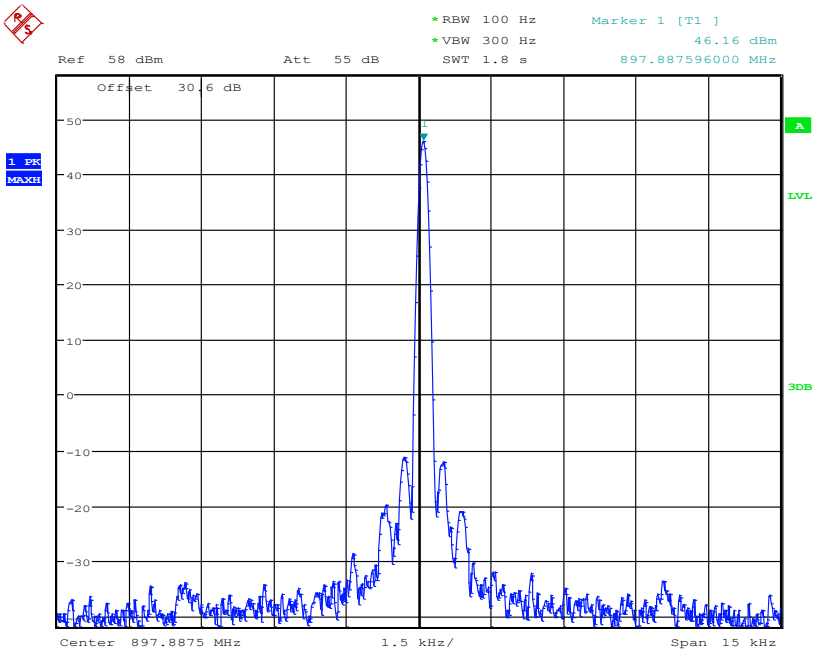

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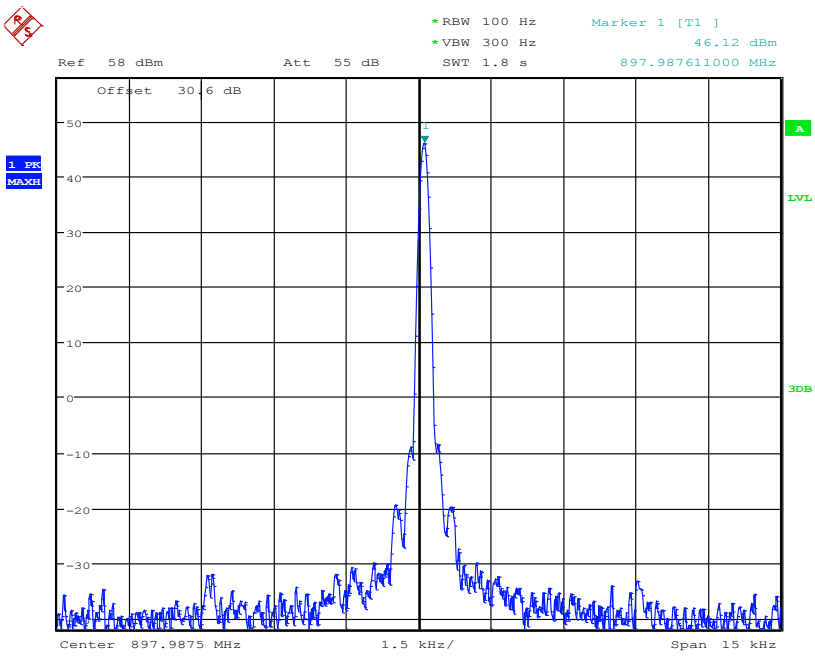

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0 °C

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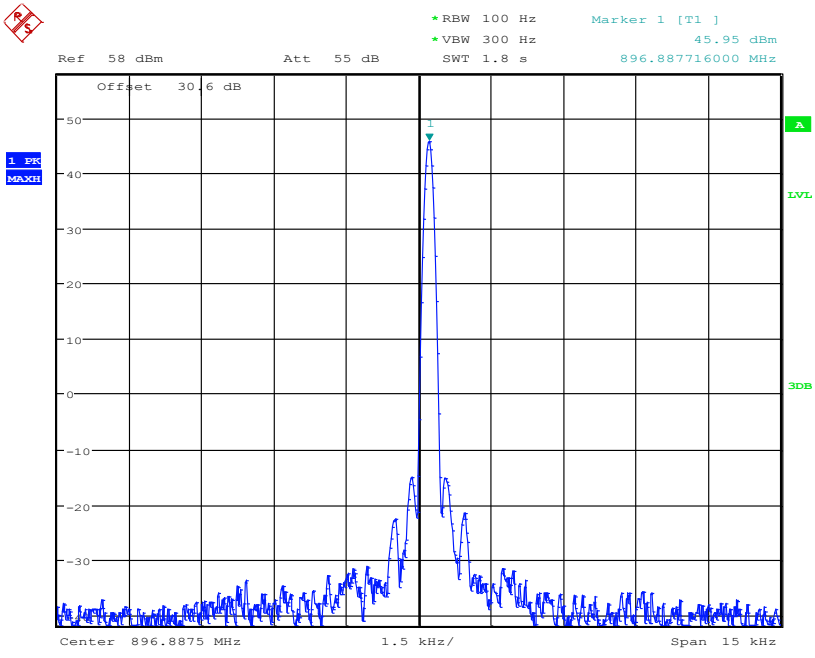

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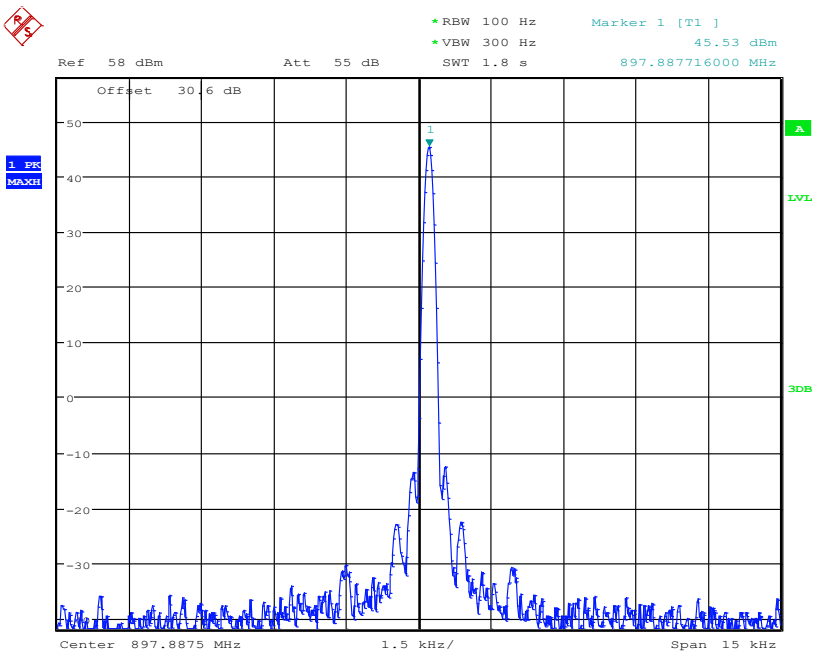

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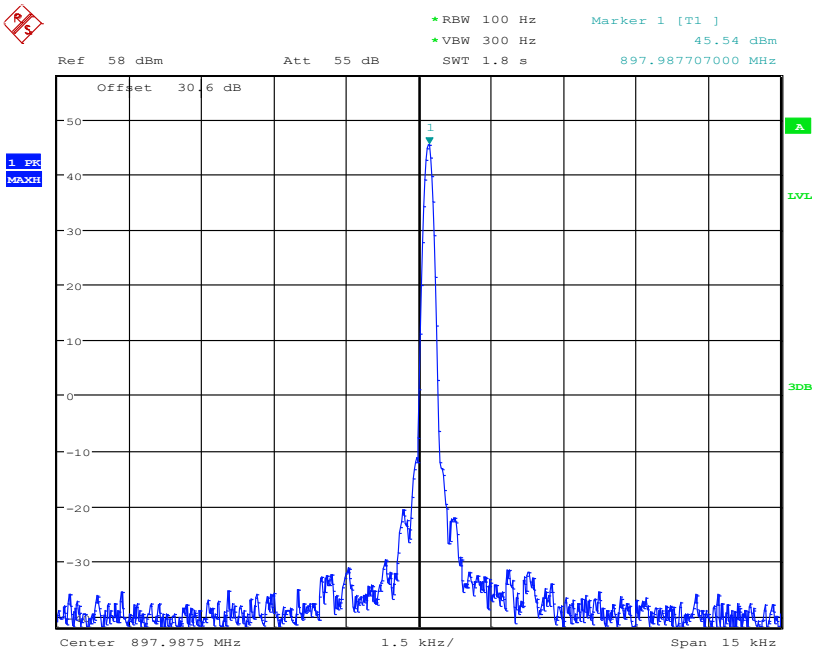

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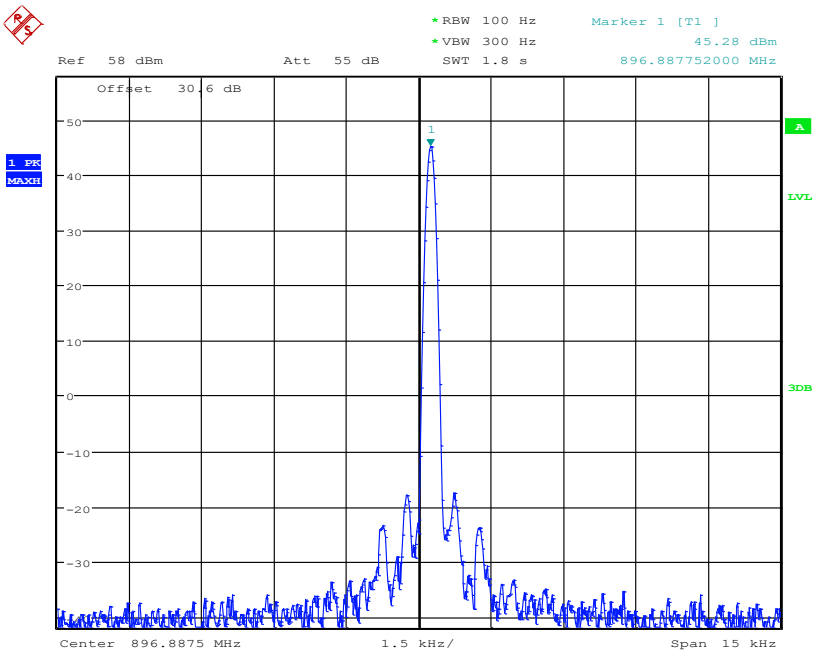
10 °C

896.8875 MHz



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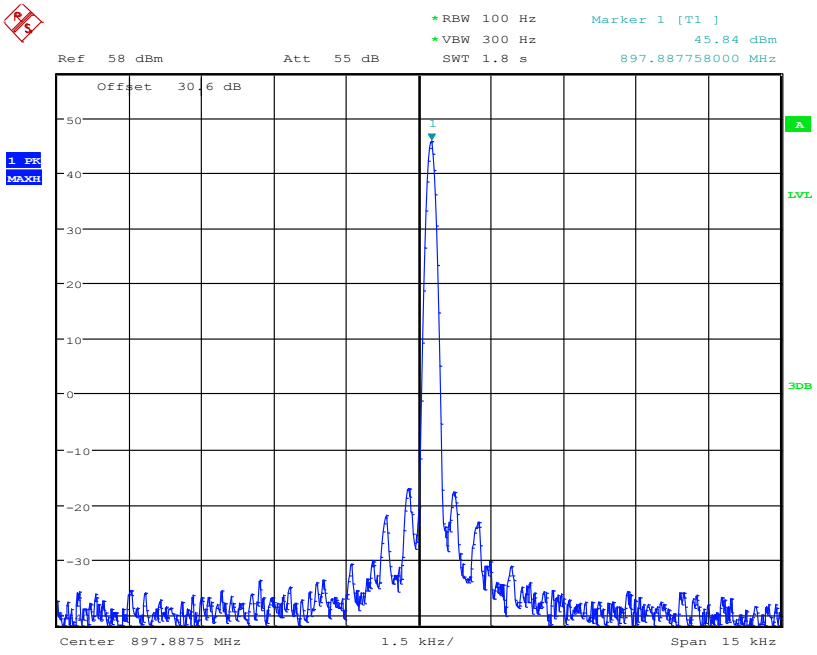

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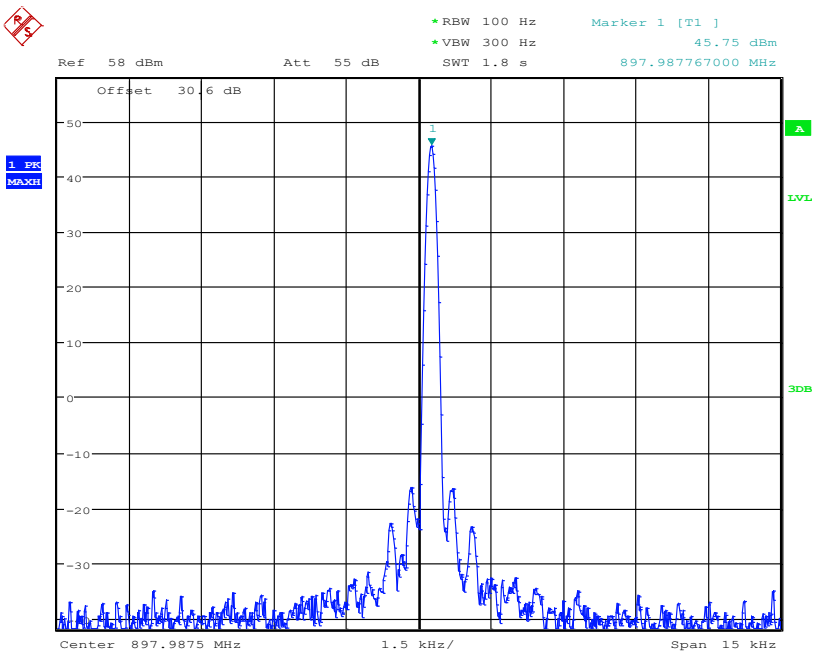

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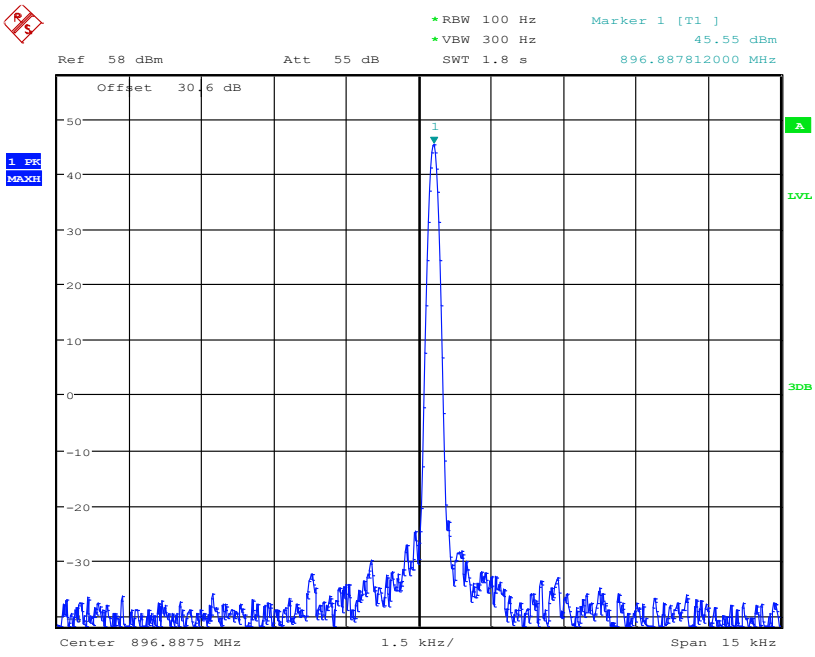
20 °C

896.8875 MHz



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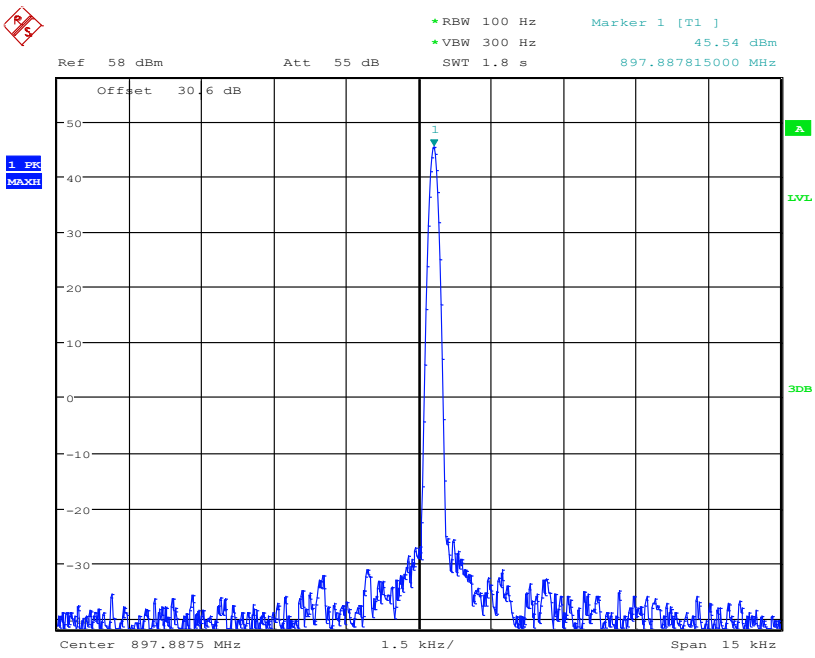
897.8875 MHz



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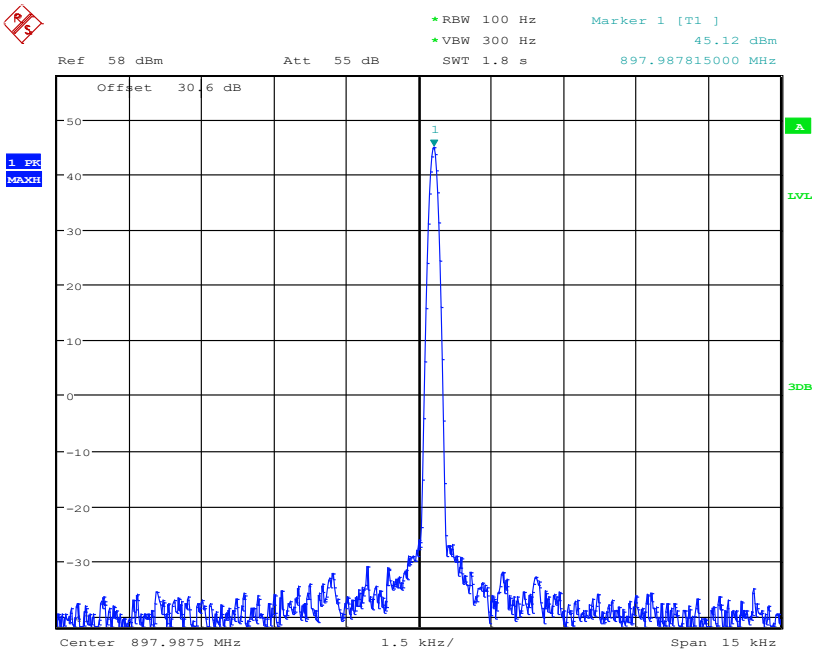
897.9875 MHz



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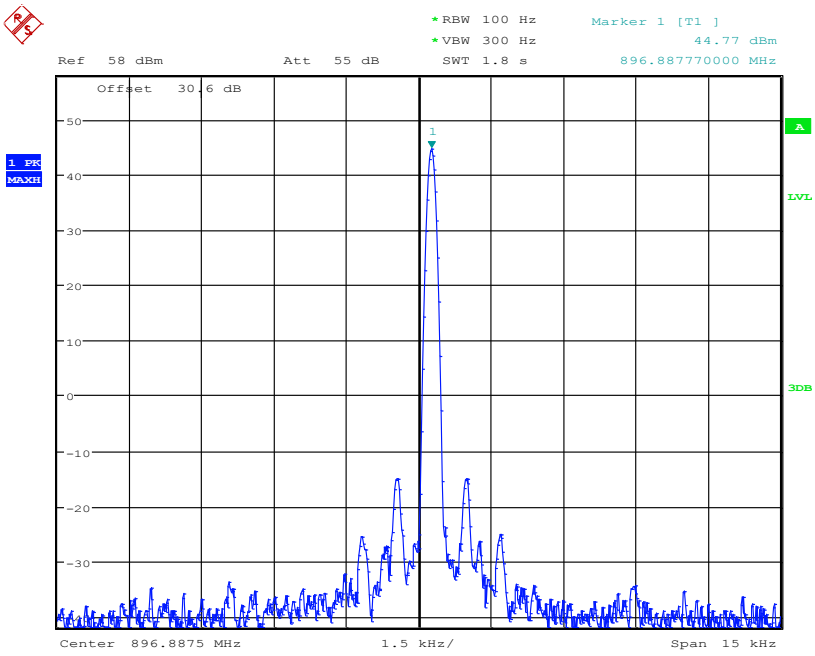
30 °C

896.8875 MHz



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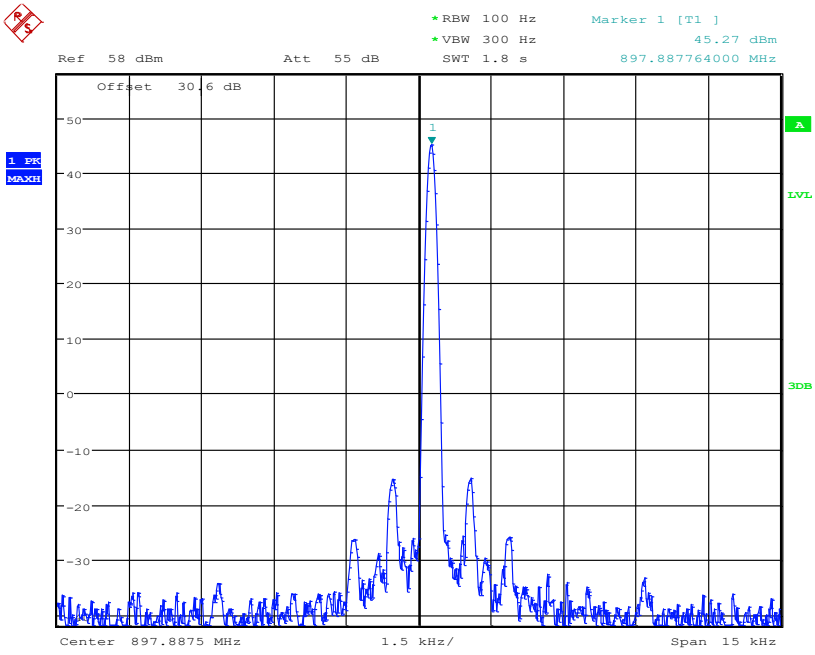
897.8875 MHz



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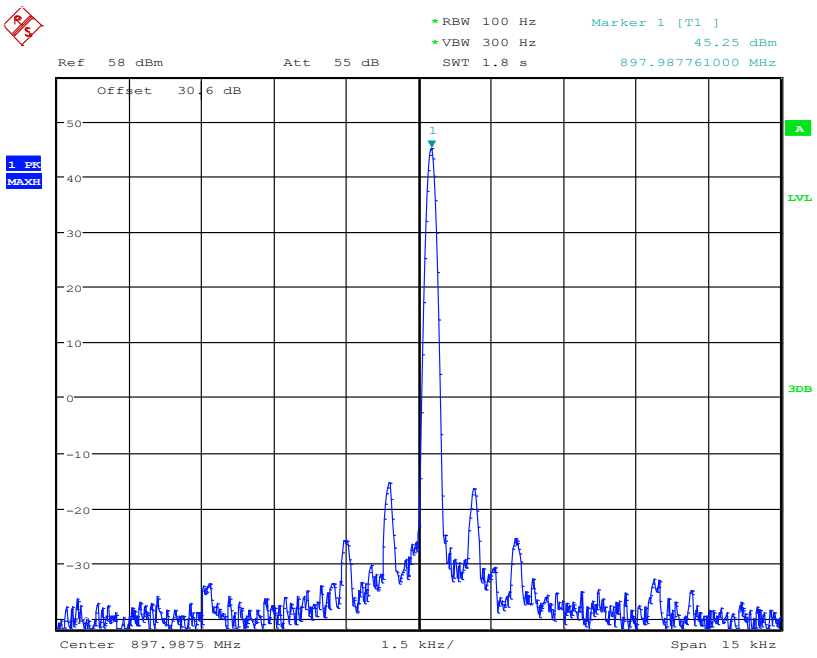
897.9875 MHz



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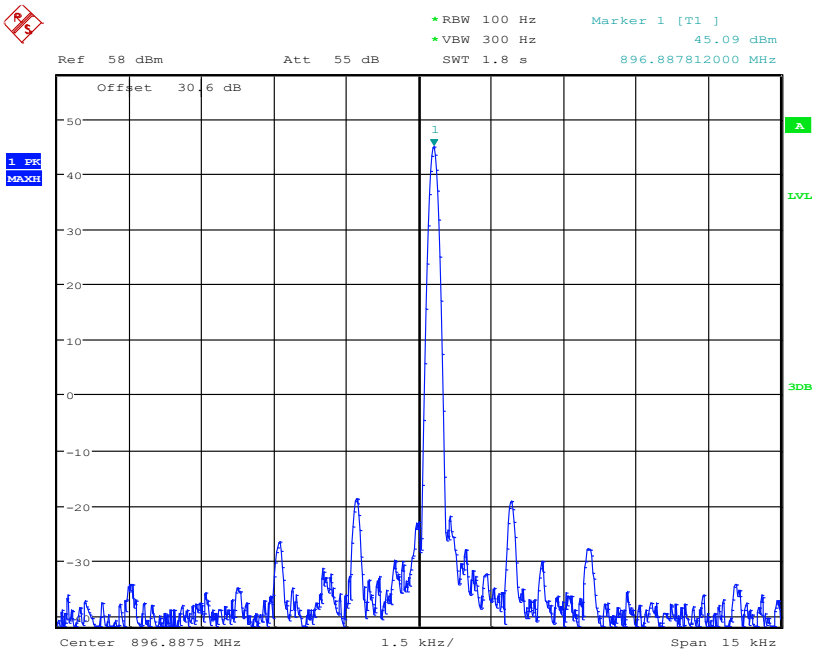
40 °C

896.8875 MHz



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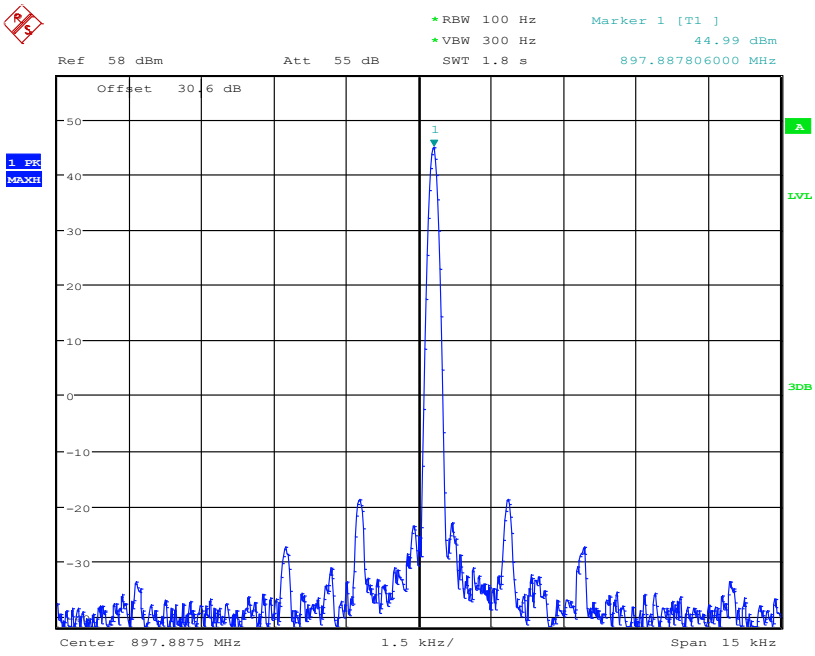
897.8875 MHz



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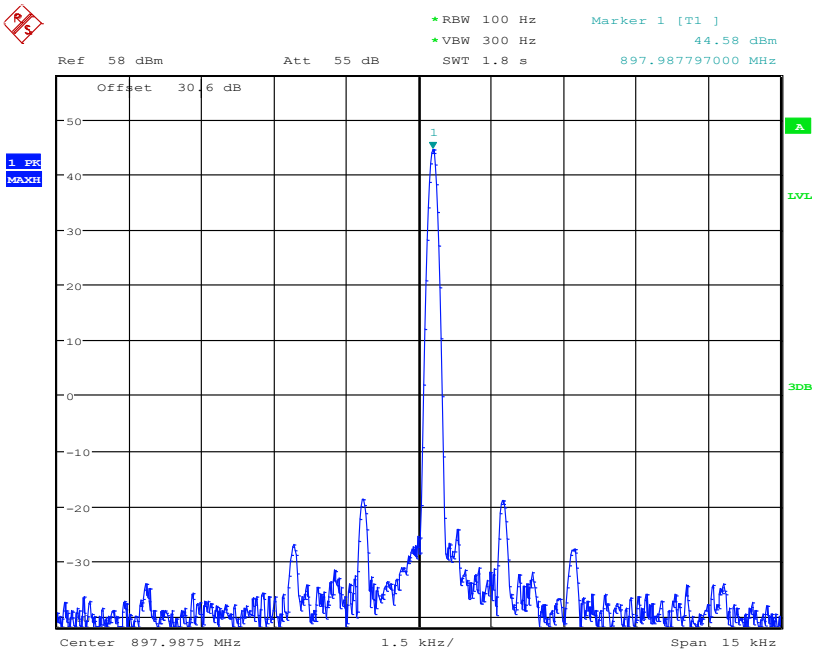
897.9875 MHz



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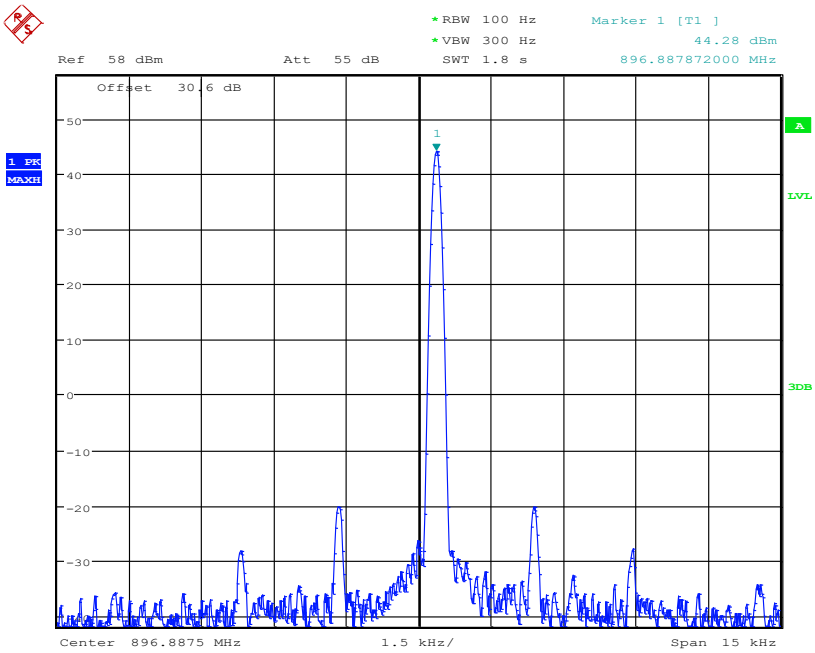
50 °C

896.8875 MHz



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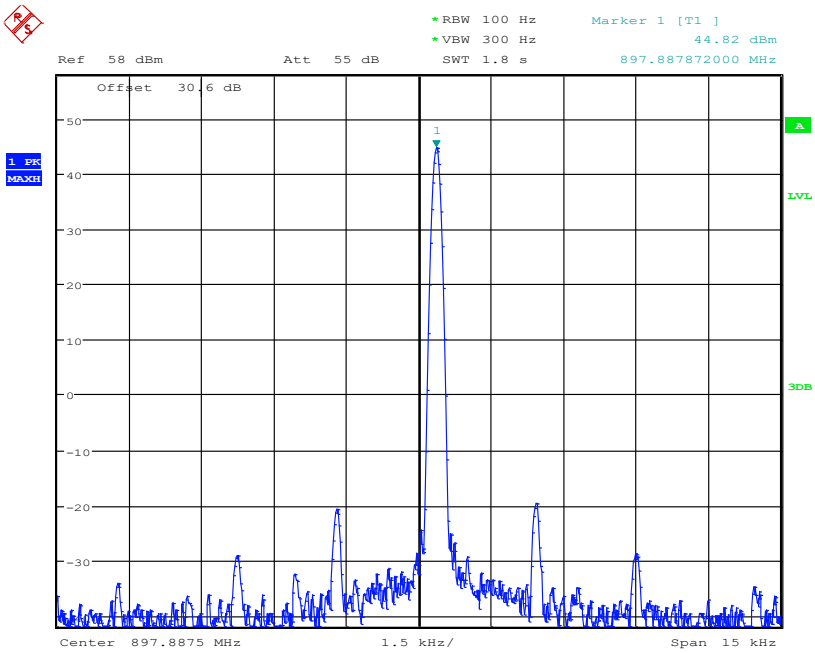
897.8875 MHz



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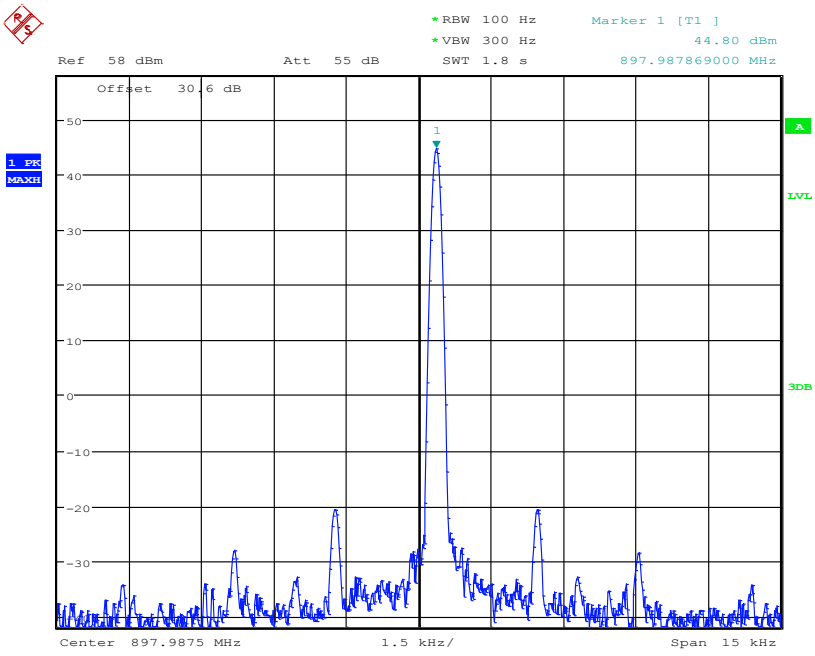
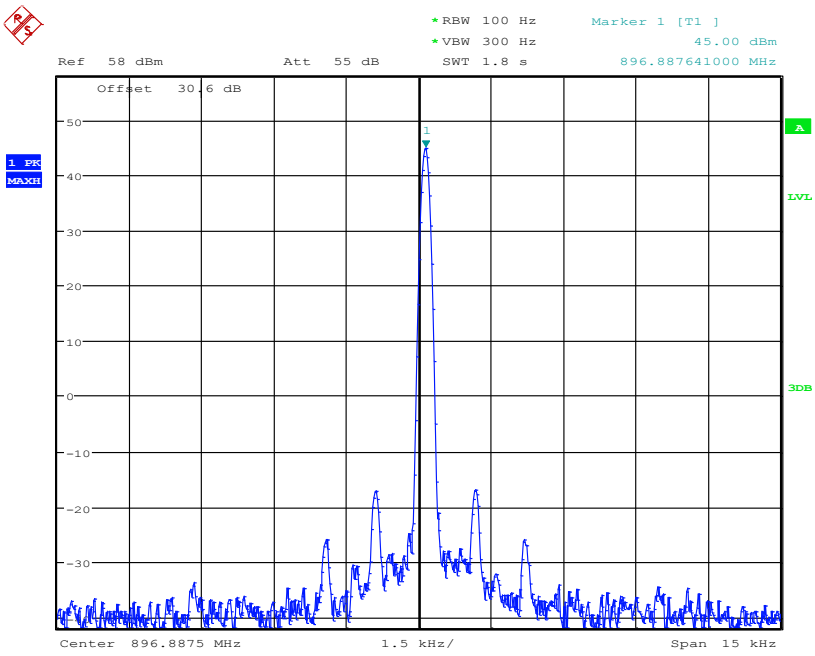
897.9875 MHz



Date: 22.JAN.2021 13:32:23

Low Voltage (20.4 V)

896.8875 MHz



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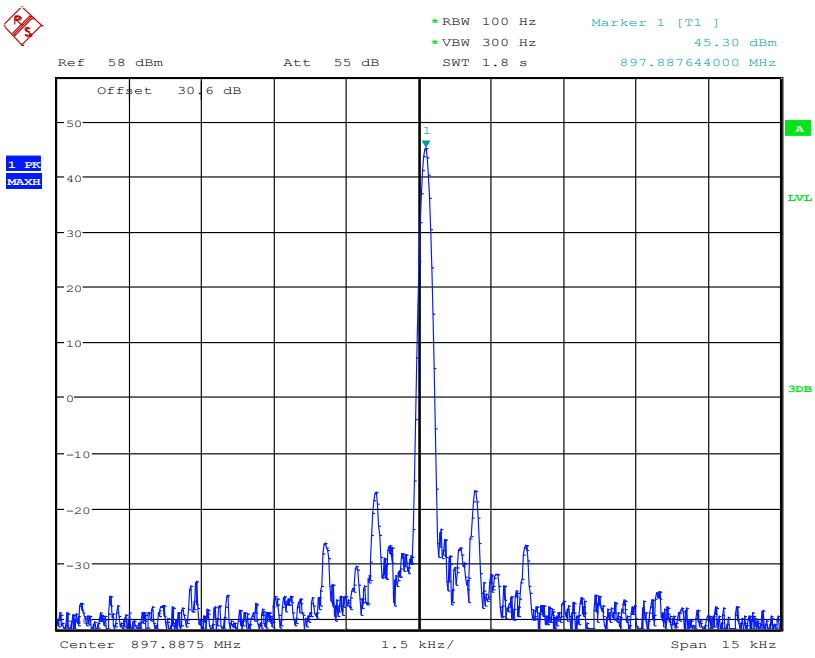
897.8875 MHz



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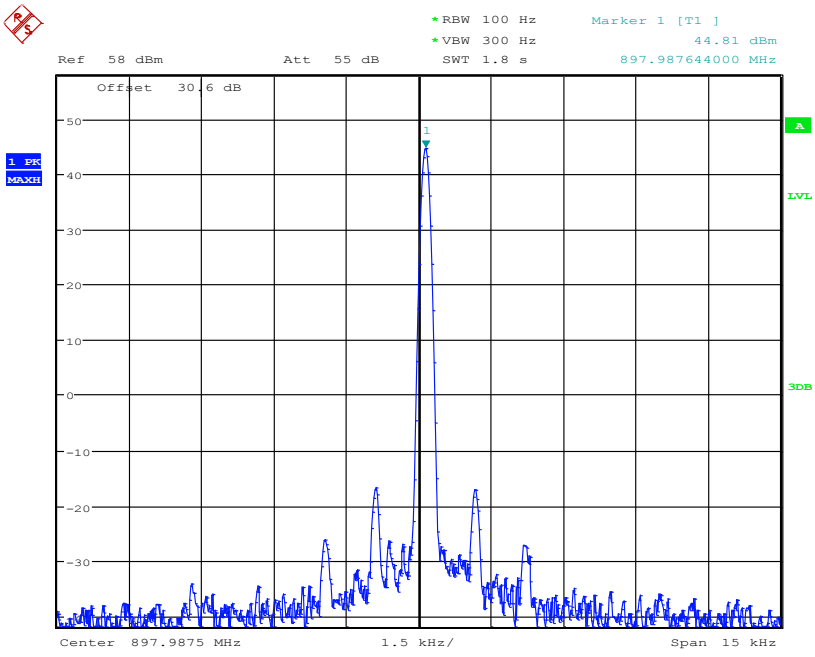
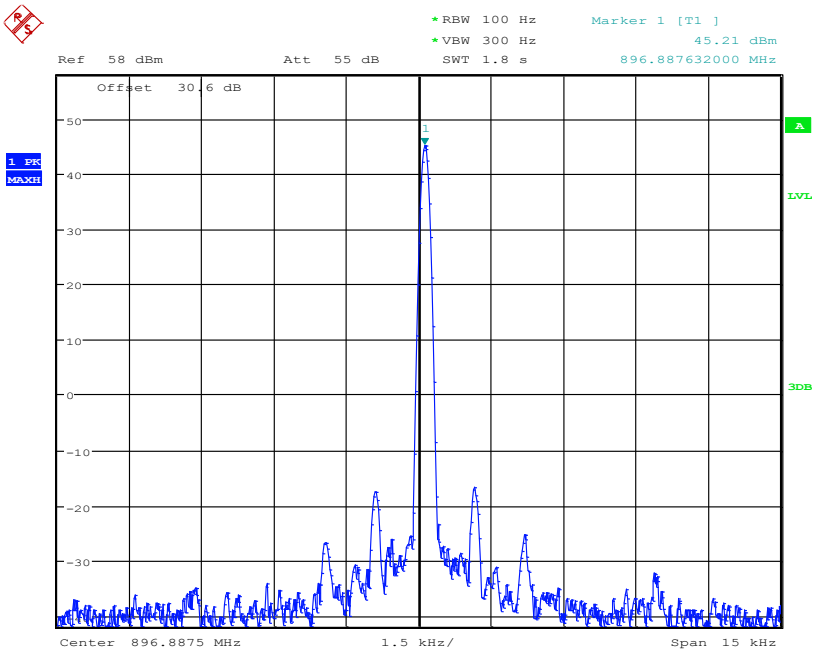
897.9875 MHz



Date: 22.JAN.2021 14:19:54

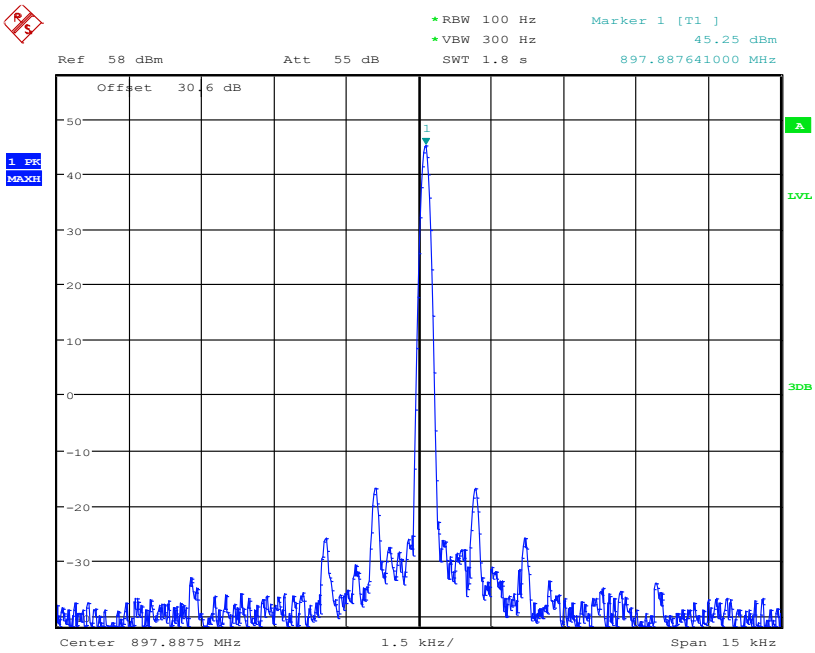
High Voltage (27.6 V)

896.8875 MHz



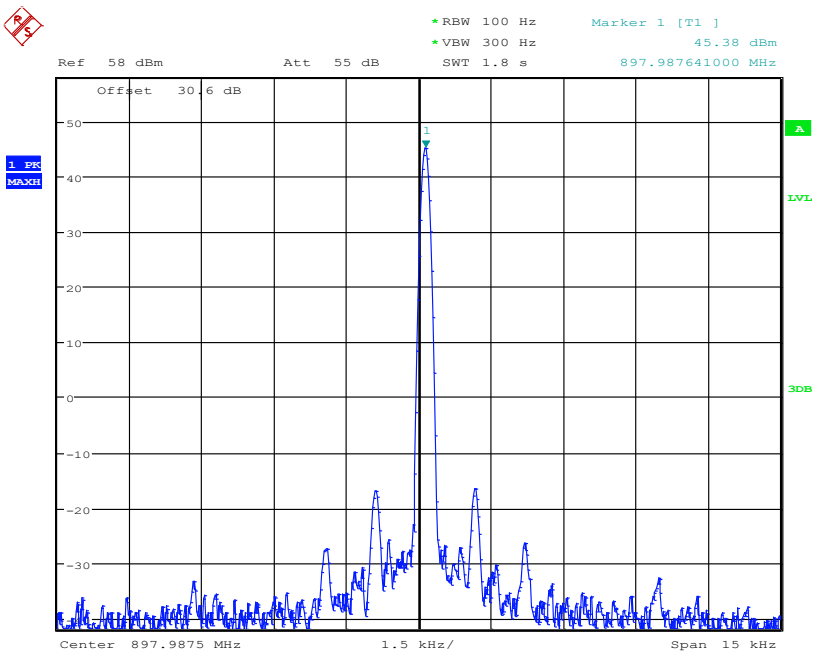
Date: 22.JAN.2021 14:16:47

897.8875 MHz



Date: 22.JAN.2021 14:17:51

897.9875 MHz



Date: 22.JAN.2021 14:18:55

10 Annex A (Normative) - EUT Setup Photographs

Please refer to the attachment

11 Annex B (Normative) – EUT External Photographs

Please refer to the attachment

12 Annex C (Normative) – EUT Internal Photographs

Please refer to the attachment

13 Annex D (Normative) – A2LA Electrical Testing Certificate

Accredited Laboratory

A2LA has accredited

BAY AREA COMPLIANCE LABORATORIES CORP.

Sunnyvale, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets A2LA *R222 - Specific Requirements EPA ENERGY STAR Accreditation Program*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 10th day of March 2021.

Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2022

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

Please follow the web link below for a full ISO 17025 scope

https://www.a2la.org/scopepdf/3297-02.pdf

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